

**NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM  
2001 RECEIVING WATER MONITORING REPORT  
RELIANT ENERGY MANDALAY GENERATING STATION  
VENTURA COUNTY, CALIFORNIA**

**2001 Survey**

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**March 2002**

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## EXECUTIVE SUMMARY

The 2001 National Pollutant Discharge Elimination System (NPDES) marine monitoring program for the Reliant Energy Mandalay generating station was conducted in accordance with specifications set forth by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) in NPDES Permit No. CA0001180 dated 26 April 2001. The 2001 studies included physical monitoring of the receiving waters and underlying sediments, and biological sampling of the benthic infaunal and fish and macroinvertebrate assemblages. Results of the 2001 surveys were compared among stations and with previous studies to determine if the beneficial uses of the receiving waters continue to be protected.

### WATER COLUMN MONITORING

Water quality parameters were measured at five surf-zone and 12 offshore stations in both winter and summer 2001. Results indicate a localized thermal plume from the generating station discharge during the winter survey in the surf zone and at one offshore station. Elevated temperatures were found at all upcoast surf-zone stations in both winter and summer. Temperature increases, where detected, were minor at offshore stations. The distribution of a thermal field around the discharge appeared to be a result of seasonal variation of local currents with a reduced tidal influence. Water temperatures were slightly higher during afternoon tide samplings, probably attributable to solar insolation. Well-developed thermoclines were present at the offshore stations in summer during both tidal cycles, a common occurrence in southern California nearshore waters during summer. Temperatures in 2001 differed somewhat from those in the study area during the 1997 to 1999 El Niño-La Niña events, returning to values typically recorded in the area. Dissolved oxygen (DO) concentrations and pH values at offshore stations were similar among stations and between tides, with no patterns relative to the discharge. Dissolved oxygen concentrations at the offshore stations were more variable than DO at the surf-zone stations in summer due to the presence of a large plankton bloom in the offshore waters resulting in atypical DO concentrations. Hydrogen ion concentrations at surf-zone stations were also similar to offshore values. All water quality measurements were within ranges recorded previously in the study area and were similar to those observed in the Southern California Bight in past studies. Only minor local effects could be attributed to the discharge at the generating station.

### SEDIMENT MONITORING

#### Sediment Grain Size

Sediments in the study area in 2001 were composed primarily of sand (average of 94%), with a mean grain size of 154  $\mu\text{m}$  (fine sand). Sediments were coarsest offshore of the discharge channel and finest at the station furthest upcoast. The relatively large amount of fine material collected at the upcoast control station is likely discharged from the Santa Clara River, less than one nautical mile upcoast from that station. Reasons for the coarser sediments off the discharge are unknown. Overall, sediment characteristics were very similar to those recorded in previous surveys since 1978. No pattern of sediment characteristics was apparent relative to the discharge. Natural causes, such as sediment deposition and transport by nearshore currents, are likely responsible for interannual variation in sediment characteristics in the study area.

#### Sediment Chemistry

In 2001, concentrations of chromium, copper, nickel, and zinc were similar among stations and to metal concentrations found in previous surveys in the study area. Sediment concentrations of all metals were highest at Station B4, nearly one nautical mile downcoast from the generating station discharge canal. Lowest concentration of copper occurred at Station B2, 2,360 ft downcoast

of the discharge, while lowest chromium and nickel concentrations occurred at Station B5, nearly one nautical mile upcoast from the discharge. Zinc concentration was lowest at Stations B2 and B5. Differences in metal concentrations among sites are often directly related to the amount of fine-grained material in the sediment. Highest metal concentrations have generally occurred at stations with the highest percentage of silt and clay combined. However, in 2001, finest sediment occurred at the upcoast control station, while highest metal concentrations occurred at the downcoast control station.

All values observed in 2001 were within the ranges found in sediments within the Southern California Bight and were lower than or comparable to levels found by the National Oceanographic and Atmospheric Administration (NOAA) at other sandy, offshore sites in southern California. Concentrations of metals in the study area have consistently been below levels determined to be potentially toxic to benthic organisms. Metal levels have remained relatively constant since 1990, with the exception of the 1991 survey. Concentrations of most metals declined between 2000 and 2001. There was no discernable pattern in 2001 that would suggest the operation of the generating station is affecting sediment metal levels in the study area.

## MUSSEL BIOACCUMULATION

Analysis of metal levels in mussels outplanted from Catalina Island in 2001 to bioaccumulate offshore of the Mandalay generating station discharge indicated bioaccumulation of metals was not appreciable. Chromium and nickel were not detected in any replicate, while copper and zinc were detected in every replicate from both Catalina Island and the outplanted mussels from Mandalay generating station. Metal levels were not elevated in comparison to the controls from Catalina or from the results noted at other locations in the Southern California Bight.

## BIOLOGICAL MONITORING

### Benthic Infauna

The infaunal community in 2001 was comprised primarily of small annelids, arthropods, mollusks, and Pacific sand dollars. Abundance varied somewhat among stations, with highest abundance immediately downcoast of the discharge and lowest abundance immediately upcoast of the discharge. Species richness and diversity were highest farthest upcoast. Abundance and species richness for the community at the discharge were slightly above the mean for the study area. Overall density of organisms averaged 5,808 individuals/m<sup>2</sup>, with a total of 75 species and an average of 29 species per station. Infaunal community composition was similar among stations, but with considerable variation in relative abundance of the numerically dominant species. The annelids *Aporionospio pygmaea*, and *Mediomastus acutus*, the arthropods *Americhelidium shoemakeri* and *Rhepoxynius menziesi*, and Pacific sand dollars were the most abundant species.

Abundance, species richness and diversity in 2001 were slightly below the long-term mean for the study area. Community composition was similar to those found in the study area since 1978, and was typical of shallow nearshore infaunal communities in the Southern California Bight. Infaunal community parameters at the five stations undoubtedly were related to sediment characteristics and did not appear to be related to the generating station discharge.

### Fish and Macroinvertebrates

Over 6,300 individuals representing 24 species of fish and weighing 87 kg were collected in the 2001 trawls. Queenfish, white croaker, and northern anchovy, the long-term community dominants, were the most abundant fish collected this year. White croaker was most abundant in winter, and queenfish in summer. Fish abundance in summer was over twice that in winter, primarily due to the large number of queenfish collected in summer. Species composition was similar to that

in prior surveys, though one fish species (tube-snout, *Aulorhynchus flavidus*) was collected in 2001 for the first time off the generating station. Abundance of macroinvertebrates was the highest on record due to the high numbers of Pacific sand dollar, which established in the nearshore of the study area between summer 1997 and winter 1999. Still, composition of the trawl-caught invertebrate community was similar to past years. While seasonal and spatial differences are apparent, no distributional pattern of fish or invertebrates was evident in relation to the discharge. There is no indication that plant operations have adversely affected the fish or macroinvertebrate populations offshore of the Mandalay generating station.

### **Impingement**

Fish impingement surveys during two normal operation and one heat treatment surveys produced six species of fish and an estimated 186 individuals. The species seen were typical of the bay environment, but the low number of individuals taken indicates that Mandalay generating station is having a negligible effect on the fish populations of Channel Islands Harbor.

### **CONCLUSIONS**

The overall results of the 2001 NPDES monitoring program indicated that operation of the Reliant Energy Mandalay generating station had no detectable adverse effects on the beneficial uses of the receiving waters.

## INTRODUCTION

This report presents and discusses the results of the 2001 receiving water monitoring studies conducted for the Reliant Energy Mandalay generating station, formerly known as the Mandalay Generating Station, owned and operated by Houston Industries. The 2001 monitoring program was conducted in accordance with specifications set forth in National Pollutant Discharge Elimination System (NPDES) Monitoring and Reporting Program No. 2093 (Permit No. CA0001180) issued by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) on 26 April 2001 (Appendix A). Results of the 2001 surveys were compared among stations and with past physical oceanographic and biological studies to determine what effects, if any, the generating station discharge is having on the marine environment, and if the beneficial uses of the receiving waters are being protected. Sampling included physical and chemical monitoring of the receiving waters and sediments, mussel bioaccumulation, and biological monitoring of the infaunal, fish, and macroinvertebrate assemblages.

## DESCRIPTION OF THE GENERATING STATION

The Reliant Energy Mandalay generating station is located on the California coast, approximately 4.8 kilometers (km) west of the City of Oxnard in Ventura County. The generating station consists of two steam-electric generating units, each rated at 215 megawatts (Mw), and one gas turbine unit rated at 147 Mw. Steam is supplied to the steam-electric units by two oil- or gas-fired boilers, each rated at 707,600 kilograms (kg) of steam per hour.

Cooling water is supplied to the station at a rate of approximately 176,000 gallons per minute (gpm), which comes from the ocean via the Edison Canal from Channel Islands Harbor, 4.8 km downcoast. Water enters the station through a screening facility which removes large marine organisms, trash, and other debris. Cooling water is pumped to the two steam condensers where its temperature is elevated approximately 12.2°C when the units are operating at full load. The warmed effluent is returned to the ocean across the beach via a rock-lined canal (Figure 1).

Approximately 9,800 gpm (6%) of the main cooling water is diverted before it reaches the steam condensers and is directed to an auxiliary heat exchanger which is used to cool distilled water used in auxiliary station equipment. The temperature of this seawater is elevated approximately 5°C before it joins the main cooling water flow in the discharge conduit. An additional 3,200 gpm (2%) is diverted to an auxiliary cooling water heat exchanger for the gas turbine unit where its temperature is raised a maximum of 9°C. The turbine unit is operated approximately 250 hours per year.

The Reliant Energy Mandalay generating station operated 4 of 4 circulators during the winter survey on 2 April 2001, discharging 253.4 million gallons per day (mgd). The intake and discharge temperatures were 18.3°C and 30.6°C, respectively, indicating an 12.3°C temperature increase. During the summer survey, 24 July 2001, 4 of 4 circulators were operated discharging 253.4 mgd. The intake temperature was 18.9°C with a discharge temperature of 29.4°C, indicating a temperature increase of 10.5°C of the water flowing through the condensers. During 2001, the Reliant Energy Mandalay generating station steam plants operated at 66.1% of their total operating capacity (Siekielec-Zdzienic 2001, pers. comm.).

## DESCRIPTION OF THE STUDY AREA

The physiography, climate, and hydrography of the southern California coastal region contribute to the character of the study area and, therefore, affect the influence of thermal discharges in coastal waters. Oceanographic, biological, and meteorological elements are all characterized by short- and long-period cyclical variations as well as non-periodic trends. Winds,

tides, and currents are particularly important since they have the greatest impact on the fate of the thermal plume itself.

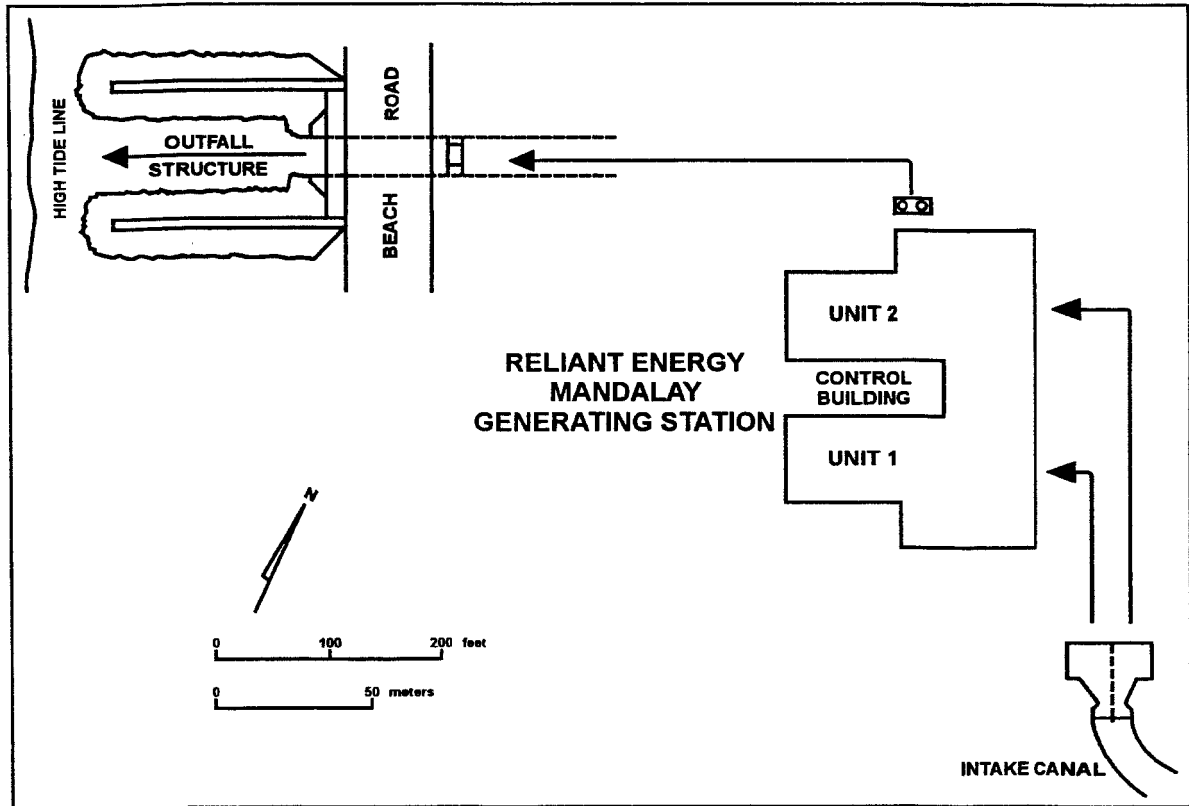


Figure 1. Diagram of the Reliant Energy Mandalay generating station cooling water system. Reliant Energy Mandalay generating station NPDES, 2001.

### Physiography

The general orientation of the coastline between Point Conception and the Mexican border is from northwest to southeast. The continental margin has been slowly emerging over time, resulting in a predominantly cliffed coastline, broken by coastal plains in the Oxnard-Ventura, Los Angeles, and San Diego areas. Drainage of the coastal region is by many relatively short streams which normally flow only during rain storms. Only a small part of the storm drainage actually reaches the ocean because most is impounded by dams and diverted for other uses.

The Reliant Energy Mandalay generating station is situated on the coastal plain of the Ventura Basin, approximately 30 km northwest of Point Mugu and 3 km south of the mouth of the Santa Clara River (Figure 2). The Ventura Basin is defined by the Ventura River delta to the north and the barrier beaches at Point Mugu to the south. Prominent natural features of this stretch of coast include straight sandy beaches, the dunes along Mandalay Beach, and the marshes and lagoon in the naval reservation near Point Mugu.

The eight islands offshore southern California strongly influence water circulation and general oceanographic characteristics of the entire Southern California Bight. The mainland shelf

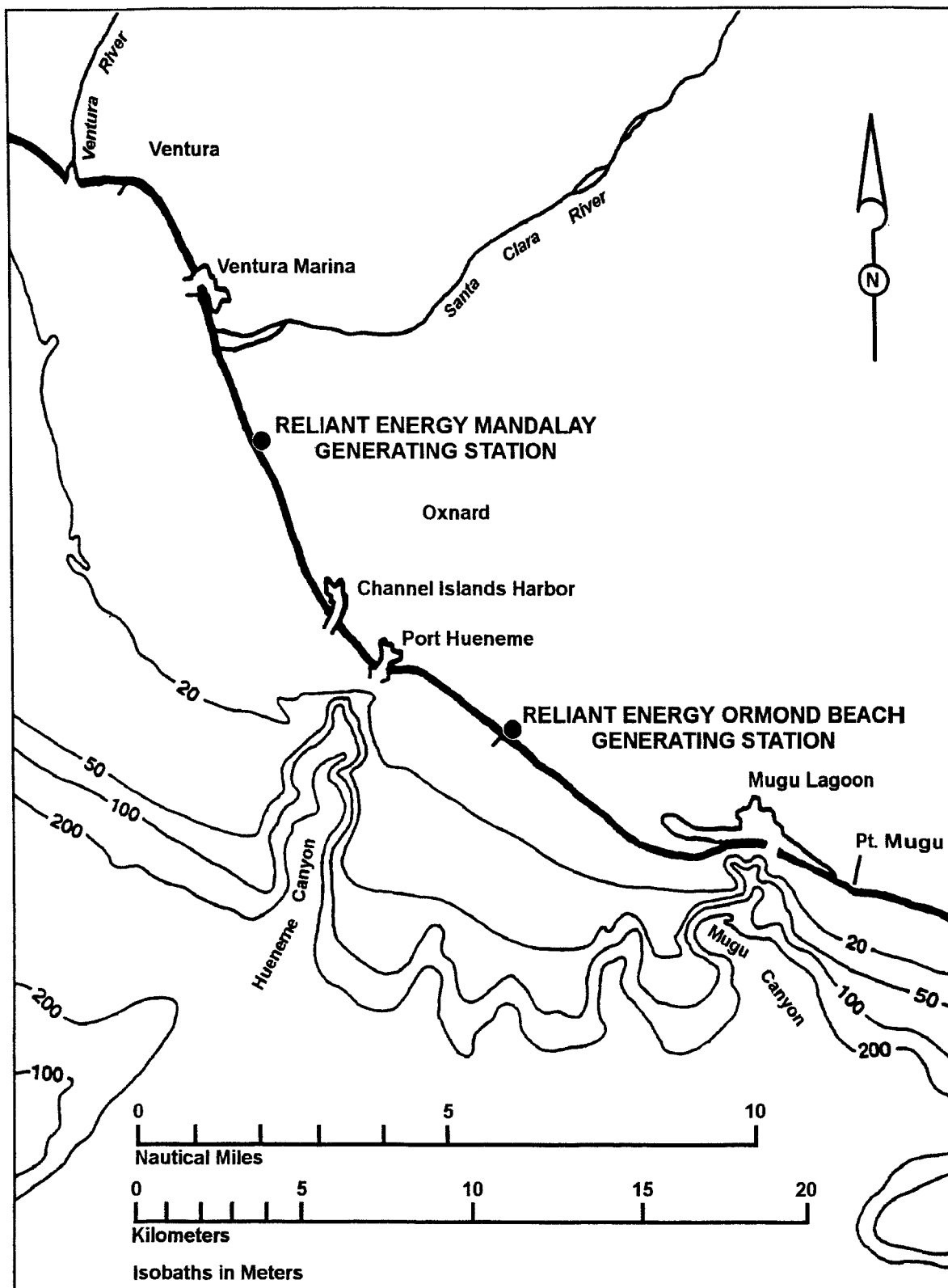


Figure 2. Location of the study area. Reliant Energy Mandalay generating station NPDES, 2001.

is narrow along the coast, ranging in width from less than 1.6 to more than 19 km, averaging approximately 7 km. Seaward of the shelf is an irregular and geologically complex region known as the continental borderland, which consists of numerous ridges and basins which extend from near the surface to depths in excess of 2,400 meters (m).

### **Submarine Physiography**

The submarine physiography of the Ventura Basin is characterized by two distinct areas divided by the Hueneme Canyon (IRC 1973). To the northwest of the Hueneme Canyon is a broad gently sloping sea floor and to the southeast a narrower, steeper slope (Figure 2). Mugu Canyon cuts into the slope near the southeastern boundary of the basin.

Offshore at Mandalay Beach, the 20 fathom (fm) contour is 12.8 to 16.0 km from shore while further south in the basin, it is closer (3.2 to 6.4 km) to shore. The head of Hueneme Submarine Canyon approaches the shoreline so closely that the 20 fm isobath is within 100 m of the jetties at Port Hueneme. There are no major irregularities in bathymetry between Hueneme Canyon and the mouth of the Ventura River.

Marked changes in bottom topography close to shore can result in irregular current patterns and variable current velocities. Nearshore circulation in the study area is affected by Hueneme and Mugu Canyons, Port Hueneme, Channel Islands Harbor, the Ventura Marina, and the mouth of the Santa Clara River. None of the studies conducted at the Reliant Energy Mandalay generating station indicated that the tidal prism from the harbors and marinas in the area significantly influence current speed and direction near the generating station.

### **Climate**

Southern California is in a climatic regime broadly defined as Mediterranean, which is characterized by short, mild winters and warm, dry summers. Long-term annual precipitation near the coast averages about 46 centimeters (cm), of which 90% occurs between November and April. Monthly mean air temperatures along the coast range from 8.3°C in winter to 20.6°C in summer, with daily minima dropping slightly below freezing and maxima reaching above 37°C.

Sea breezes, which develop from differential heating between land and sea masses, combine with the prevailing winds from the northwest during summer months to produce strong onshore winds. Summer sea breezes typically start at about noon and may continue through late afternoon, with speeds reaching 37 km/hour (hr). In late fall and winter, reverse pressure systems frequently develop; coastal winds tend to be from the southeast and the sea breezes typically blow from 1300 hr to as late as 2000 hr.

### **Ocean Currents**

Water in the northern Pacific Ocean is driven eastward by prevailing winds until it impinges on the western coast of North America where it divides and flows both north and south. The southern component comprises the California Current, a diffuse and meandering water mass which generally flows to the southeast, following the coast. There is no fixed western boundary to this current, but more than 90% of its transport is within 725 km of the California coast. South of Point Conception, the California Current generally flows along the Patton Escarpment (160 km offshore) and approaches the coast again near Cape Colnett, Baja California (Figure 3). Off Baja California part of the California Current turns north forming a counter-current in the Southern California Bight known as the Southern California Countercurrent. Part of this countercurrent flows through the Santa Barbara Channel and then rejoins the California Current while the rest turns and flows south nearshore. Nearshore, coastal currents are strongly influenced by a combination of wind, tides, and

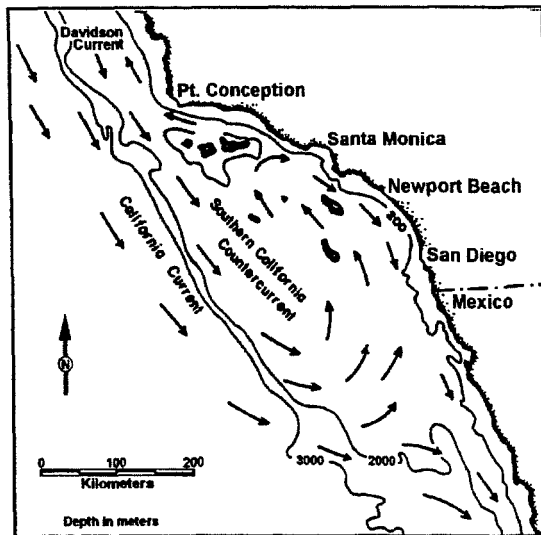


Figure 3. Surface circulation in the Southern California Bight (from Jones 1971). Reliant Energy Mandalay generating station NPDES, 2001.

local physiography. Therefore, short-term observations of currents near the coast often vary in both direction and speed.

Surface speed in the countercurrent ranges between 5.5 and 11 centimeters per second (cm/s). The general flow pattern is complicated by eddies in the Channel Islands region and fluctuates seasonally, being more strongly developed in summer and autumn, and weak or occasionally absent in winter and spring.

### Longshore Drift

Longshore currents typically move sand parallel to shore and thus toward the heads of submarine canyons either upcoast or downcoast. In the Hueneme area southeast of Mandalay, the net littoral sediment transport, or longshore drift, is downcoast at the rate of 600,000 to 900,000 m<sup>3</sup> per year. When the entrance to Port Hueneme was constructed, the upcoast jetty effectively trapped or diverted the natural sand supply that

was formerly available to beaches in the Ormond Beach area. That portion of sediment not trapped by the jetty was lost into deep water at the head of the Hueneme Canyon. Approximately 900,000 m<sup>3</sup> per year are eroded downcoast of the jetties. Slightly more than 1,500,000 m<sup>3</sup> of sediment are dredged and bypassed biannually around the trap. Erosion southeast of the harbor continues, however, at a rate of approximately 1,500,000 m<sup>3</sup> per year.

Channel Islands Harbor was designed to prevent sediment loss into Hueneme Canyon. The detached breakwater at the harbor entrance provides a shadow zone which traps sediment upcoast of the northwest jetty. In 1960-61, dredging of the sand trap, the entrance channel, and the first phase of development at Channel Islands Harbor provided about 4,120,000 m<sup>3</sup> of sand which were used for beach nourishment (IRC 1973). To the northwest of Reliant Energy Mandalay generating station the normal southeasterly movement of sediment from the Ventura River area is interrupted by the trap effect of Ventura Marina breakwater and jetties.

### Tides

Tides along the California coast are mixed, semidiurnal, with two unequal highs and two unequal lows during each 25 hr period. The tide is a long-period wave that is a combination of semidiurnal components (each having nearly 12 hr periods) and diurnal components with nearly 25 hr periods. In the eastern North Pacific Ocean, the tide wave rotates in a counterclockwise direction so that tidal extremes occur progressively later in the day northwards along the coast. As a result, flood tide currents flow upcoast and ebb tide currents flow downcoast.

### Upwelling

The predominant northwesterly winds are responsible for large scale upwelling along the California coast. From about February to October, these winds induce offshore movement of surface water which is replaced by the upwelling of deeper ocean waters. The upwelled water is colder, more saline, lower in oxygen, and higher in nutrient concentrations than surface waters. Thus, upwelling not only alters the physical properties of the surface waters but also enhances biological productivity.

## RECEIVING WATER CHARACTERISTICS

The capacity of the marine environment to assimilate heated cooling water depends on its ability to dilute and disperse the thermal discharge. The extent to which these functions are accomplished depends on the quantity and temperature of the thermal effluent relative to normal ocean temperatures and ocean current patterns as well as other characteristics of the receiving waters. These factors are the primary determinants of the fate and effect of thermal effluent discharge. The following discussion focuses on natural physical and chemical oceanographic characteristics that influence the local marine biota.

### Temperature

Natural water temperatures fluctuate throughout the year in response to seasonal and diurnal variations in currents; meteorological conditions such as wind, air temperature, relative humidity, and cloud cover; and parameters such as ocean waves and turbulence. Natural temperature is defined by the California State Water Resources Control Board (1972) as "the temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge or irrigation return waters."

Daily surface water temperatures may be expected to vary 1°C to 2°C in summer and 0.3°C to 1°C in winter on the average. Factors contributing to rapid daytime warming of the sea surface are weak winds, clear skies, and warm air temperatures; factors that limit diurnal temperature ranges are overcast skies, moderate air temperatures, and mixing of the surface waters by winds and waves.

Between July 1970 and January 1973 natural surface water temperatures at nearby Ormond Beach ranged from 11.4°C in December 1971 to 22.0°C in August of the same year. During 1971-1972 minimum and maximum surface water temperatures at a control station offshore from the Reliant Energy Mandalay generating station were 11.6°C and 22.7°C, respectively (IRC 1973).

When there is a large difference between surface and bottom water temperatures, a steep temperature gradient between adjacent water layers of different temperatures (i.e., a thermocline) may develop. Natural thermoclines are formed when absorption of solar radiation at the sea surface develops a stable stratification, separating surface from subsurface layers. Off southern California, a reasonably sharp thermocline is normally found in summer in the upper 30 m of the water column; in winter thermoclines are weakly defined. Artificial thermoclines may result when warm water from a thermal discharge overlies cooler receiving waters.

### Salinity

Salinity is a measure of the concentration of dissolved salts, and although relatively constant in the open ocean, it fluctuates in coastal environments as a result of the introduction of freshwater runoff and direct rainfall, and through the evaporation of freshwater. Between 1965 and 1971 surface salinity at the Ventura Marina ranged from a minimum of 24.1 parts per thousand (ppt), which was associated with rainfall runoff, to a maximum of approximately 33.9 ppt (IRC 1973).

### Dissolved Oxygen

Dissolved oxygen (DO) is utilized by aquatic plants and animals in their metabolic processes; it is replenished by gaseous exchange with the atmosphere and as a byproduct of photosynthesis. High values generally result from photosynthetic activity and low values from mixing of surface waters with oxygen-depleted subsurface waters. Between July 1970 and January 1973, concentrations in surface waters offshore Ormond Beach ranged from 7.3 milligrams per liter (mg/l) to 11.0 mg/l (IRC 1973).

### **Hydrogen Ion Concentration**

The hydrogen ion concentration (pH) in southern California surface waters varies narrowly around a mean of approximately 8.0 and decreases slightly with depth. Maximum pH values recorded during four quarterly surveys conducted offshore Ormond Beach between December 1973 and September 1974 were 8.0 to 8.6 (EQA/MBC 1975).

### **BENEFICIAL USES OF RECEIVING WATERS**

The Water Quality Control Plan for the Santa Clara River Basin (California Regional Water Quality Control Board 1994) lists seven beneficial uses of waters in the nearshore zone of the Santa Clara Calleguas Hydrographic Unit and one more (Industrial Water Supply) for the Edison Canal Estuary.

#### **Water Contact Recreation (REC-1)**

This includes activities such as swimming, wading, skin or SCUBA diving, waterskiing, surfing, sport fishing, and other uses where actual body contact with water is made and the ingestion of water is reasonably possible.

#### **Non-contact Water Recreation (REC-2)**

This beneficial use involves the presence of water but does not require contact with it, such as picnicking, sunbathing, hiking, beachcombing, camping, and pleasure boating.

#### **Navigation (NAV)**

This use is defined as commercial and naval shipping uses.

#### **Marine Habitat (MAR)**

This use provides for the preservation of the marine ecosystem including the propagation and sustenance of fish, shellfish, marine mammals, water fowl, and vegetation such as kelp.

#### **Ocean Commercial and Sport Fishing (COMM)**

These beneficial uses include the commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in ocean, bays, estuaries, and similar non-freshwater areas.

#### **Shellfish Harvesting (SHELL)**

This beneficial use includes the collection of shellfish such as clams, oysters, abalone, shrimp, crab, and lobster for either commercial or sport purposes.

#### **Preservation of Rare and Endangered Species (RARE)**

This beneficial use involves the provision of an aquatic habitat, at least in part, for the survival of certain species that have been established as being rare and endangered.

**Wildlife Habitat (WILD)**

This use provides for the preservation of terrestrial ecosystems including vegetation, wildlife, and the water and food sources that are found therein.

**Industrial Service Supply (IND)**

This is a beneficial use which does not depend primarily on water quality and includes cooling water supply.

Although all of the above uses may not directly apply to the generating station's receiving waters at all times, they may be reasonably assumed to constitute occasional beneficial uses of nearshore waters in the study area.

**MATERIALS AND METHODS****SCOPE OF THE MONITORING PROGRAM**

The 2001 monitoring program for the Reliant Energy Mandalay generating station was conducted by MBC Applied Environmental Sciences (MBC) in accordance with specifications set forth in the NPDES Monitoring and Reporting Program (Appendix A). The monitoring program included winter and summer water column profiling, summer sediment sampling for grain size and chemistry, mussel sampling for bioaccumulation, summer biological sampling for benthic infauna, and winter and summer trawling for fish and macroinvertebrates.

**STATION LOCATIONS**

The locations of the monitoring stations are described in Appendix A and shown on Figure 4. The 2001 monitoring program included 17 water quality (RW) stations, four trawl (T) stations, and five sediment and benthic infauna (B) stations.

**WATER COLUMN MONITORING**

Temperature (°C), dissolved oxygen (DO), hydrogen ion concentration (pH), and salinity (ppt) were measured during the winter and summer surveys. Sampling was conducted on both flood and ebb tides at each of the receiving water monitoring stations (Figure 3). Data at the 12 offshore stations, Station RW6 through RW17, were obtained *in situ* throughout the water column using an SBE 9/17 CTD water quality profiling system (Sea-Bird), and averaged at 1.0 m intervals. In the field, the data were transferred from the Sea-Bird to floppy disk for storage. In the laboratory, data were processed using Sea-Bird proprietary software (SeaSoft ver. 4.21). Measurements at the five surf-zone water quality stations, Stations RW1 through RW5, were obtained using a Horiba U-10 water quality analyzer. The resulting information was imported into Microsoft Excel spreadsheets for further reduction and analysis.

**SEDIMENT MONITORING****Sediment Grain Size**

At each of the five benthic stations (Stations B1 - B5), biologist-divers collected one sediment sample for grain size analyses using a 15-cm-long, 3.5-cm diameter plastic core tube. Sediment samples were collected at the same time as infaunal samples, and placed in plastic bags for later laboratory analysis.

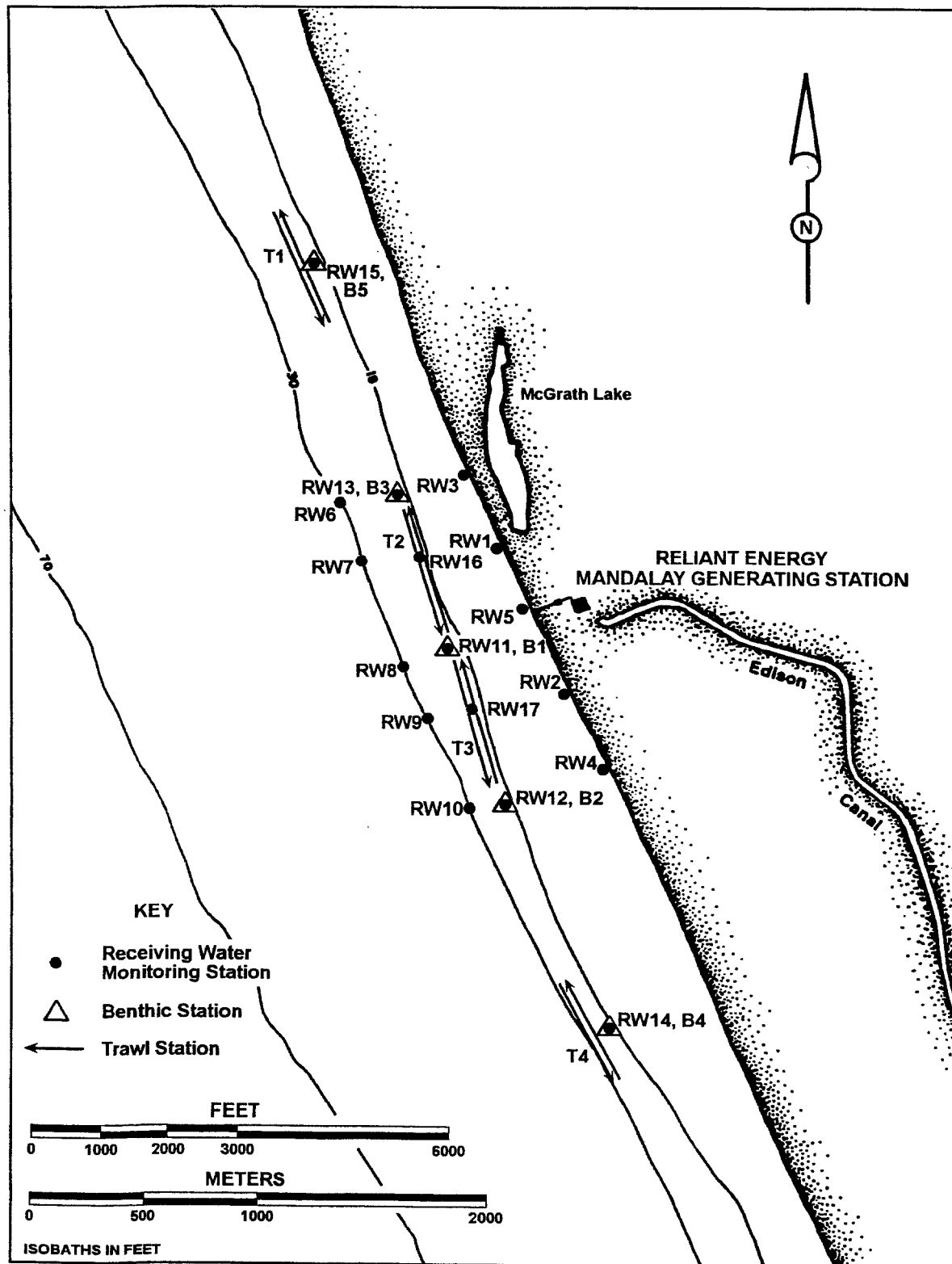


Figure 4. Location of the monitoring stations. Reliant Energy Mandalay generating station NPDES, 2001.

The size distributions of sediment particles were determined using two techniques: laser light diffraction to measure the amount and patterns of light scattered by a particle's surface for the sand/silt/clay fraction, and standard sieving for the gravel fraction. Laboratory data from the two methods were combined and presented in tabular format. Resulting analyses include mean and median grain size, standard deviation of the grain size, sorting, skewness, and kurtosis. Data were plotted as size-distribution curves. Additional details are provided in Appendix B.

### Sediment Chemistry

Sediment samples were collected for chemical analysis at the benthic stations (Stations B1 - B5) during the summer survey at the same time as the infaunal samples. Biologist-divers collected one liter of sediment at each of five stations (Figure 4). Sediment chemistry samples were placed on ice in the field and returned to the laboratory. Samples for metal analysis were maintained at approximately 4°C until laboratory procedures began. Sediments were analyzed for total percent solids, and the following metals: chromium, copper, nickel, and zinc. Environmental Protection Agency (EPA) method 160.3 was used for determining percent solids while EPA method 6010 was used for metal analysis. Data were converted to dry weight values.

### MUSSEL BIOACCUMULATION

Bay mussels (*Mytilus edulis*) were taken from a relatively pristine area on the west end of Catalina Island and outplanted at a mooring situated in 6 m of water directly offshore of the Mandalay discharge for a period of 90 days. The mussels were then collected by biologists during the summer survey for bioaccumulation monitoring. Forty-three (43) mussels with shell lengths ranging from 53 to 77 millimeters (mm) and averaging 62.1 mm were processed according to methods used in the California Mussel Watch (Appendix A and SWRCB 1986). Soft tissue from the mussels was analyzed for copper, chromium, nickel, and zinc. Results were compared to levels found in other mussel watch programs.

### BIOLOGICAL MONITORING

The biological monitoring program consisted of benthic infauna sampling using diver-operated box corers and otter trawling of fish and macroinvertebrates.

#### Benthic Infauna

Benthic infaunal sampling was conducted at the five benthic stations (Stations B1 - B5) by collecting four replicate cores using a hand-held, diver-operated box corer (Figure 5). The box corer collects a uniform sample of 100.0 cm<sup>2</sup> surface area to a depth of 10.0 cm for a total sample volume of 1.0 liter (l). The box corer is pushed into the sediments by a diver. Upon withdrawal from the sediments, the sample is sealed in the box by a neoprene cover for transport to the surface.

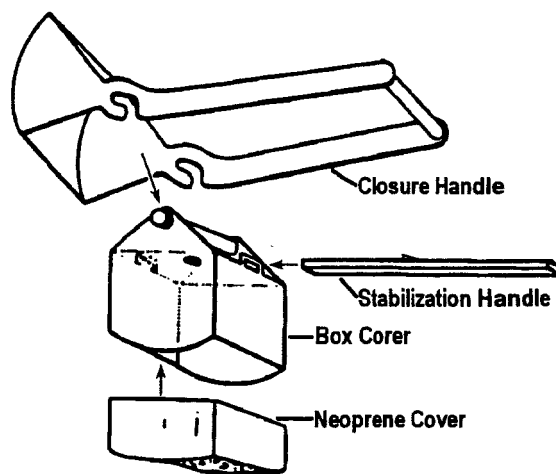


Figure 5. Diver-operated box corer used to collect infaunal samples. Reliant Energy Mandalay generating station NPDES, 2001.

Samples were screened in the field using a 0.5 mm screening system, labeled, and fixed in buffered 10% formalin-seawater. In the laboratory, samples were transferred to 70% isopropyl

alcohol, sorted to major taxonomic groups, identified to the lowest practical taxonomic level, and counted. Representative specimens were added to MBC's reference collection.

### **Fish and Macroinvertebrates**

Otter trawl sampling in the waters offshore of the Reliant Energy Mandalay generating station was conducted at Stations T1 - T4. Two replicate trawls were made at the four stations (Figure 4). All trawls were made with a 25-foot (ft) wide Marinovich semi-balloon otter trawl net. The footrope was weighted with chain and equipped with plastic rollers to reduce fouling. The body of the net consisted of the 1.5 inch (in.) bar mesh with a 0.5 in. bar mesh liner in the cod end. When towed along the bottom, the net inflates by the buoying effect of floats attached to the upper edge of the mouth and the hydrofoil action of the otter boards at either side.

The otter trawl was towed at 2.0 to 2.5 knots (kn) for 10 minutes and measured from the time it was on the bottom to the time retrieval commenced. Each catch was immediately separated from incidental debris, then sorted to species. Fishes were identified, enumerated, measured and examined for external parasites, anatomical anomalies, and other abnormalities. Aggregate weights were taken by species. Specimens were then returned to the sea along with macroinvertebrates which were identified, counted, and weighed.

Unusual specimens and those of uncertain identity were preserved in 10% formalin-seawater and returned to the laboratory for positive species determination and, if warranted, were retained in the MBC voucher collection.

### **Impingement**

Impingement sampling is conducted during representative periods of normal operation and during all heat treatment procedures to obtain an estimate of total impingement for the year. A normal operation survey is defined as a sample of all fish and macroinvertebrates entrained by water flow into the generating station intake and subsequently impinged onto traveling screens during a 24-hr period with all circulating pumps operating, if possible. The number of operational days is usually less than 365 because of plant maintenance downtime and seasonal fluctuations in the demand for electricity, which may result in decreased water flow into the power plant. Normal operation abundance and biomass for the year are estimated by extrapolating the monitored abundance and biomass based on the percentage of the annual flow into the plant on the days sampled. Exceptions to this method are made where such extrapolations would result in exaggerated counts for species that typically occur in low abundance.

A heat treatment is an operational procedure designed to eliminate mussels, barnacles, and other fouling organisms which grow in and occlude the generating station conduits. During a heat treatment, heated effluent water from the discharge conduit is re-entrained via cross-connecting tunnels to the intake conduit until the water temperature rises to approximately 40.5°C in the screenwell. This temperature is maintained for a period of at least one hour during which time all mussels, barnacles, and incidental fish and invertebrates living within the intake conduit and forebay succumb to the heated water. All material is subsequently impinged onto the traveling screens and removed from the forebay. The fish and macroinvertebrates are then separated from incidental debris, sorted by species, identified, and counted. Fish are measured in millimeters to either standard length (SL), total length (TL), or disc width (DW), as appropriate, and examined for external parasites, anatomical anomalies, and other abnormalities. Aggregate weights are taken by species for both fish and macroinvertebrates. Unusual specimens and those of uncertain identity are preserved in 10% formalin-seawater and returned to the laboratory for positive species determination and, if warranted, retention in the MBC collection of voucher species. Data are collected for at least two heat treatment surveys and combined with the estimated normal operation data to determine the total impingement loss for the year.

## STATISTICAL ANALYSES

Summary statistics developed from the biological data included the number of individuals (expressed as both trawl and per standard area), number of species and Shannon-Wiener (Shannon and Weaver 1962) species diversity ( $H'$ ) index.

The diversity equation is as follows:

Shannon-Wiener

$$H' = - \sum_{j=1}^S \frac{n_j}{N} \ln \frac{n_j}{N}$$

where:  $H'$  = species diversity  
 $n_j$  = number of individuals in the  $j^{\text{th}}$  species  
 $S$  = total number of species  
 $N$  = number of individuals

Data from trawl and infaunal coring collections were subjected to log transformations (when necessary) and classified (clustered) using the SYSTAT (SYSTAT ver. 5.0, Systat, Inc., Evanston, IL) clustering module (Wilkinson 1986). Cluster analysis provides a graphic representation of the relationship between species, their individual abundance, and spatial occurrence among the stations sampled. In theory, if physical conditions were identical at all stations, the biological community would be expected to be identical as well. In practice this is never the case, but it is expected that the characteristics of adjacent stations would be more similar than those distant from one another. The dendrogram shows graphically the degree of similarity (and dissimilarity) between observed characteristics and the expected average. The two-way analysis utilized in this study illustrates groupings of species and stations, as well as their relative abundance, expressed as a percent of the overall mean. Two classification analyses are performed on each set; in one (normal analysis) the sites are grouped on the basis of the species which occurred in each, and in the other (inverse analysis) the species are grouped according to their distribution among the sites. Each analysis involves three steps. The first is the calculation of an inter-entity distance (dissimilarity) matrix using Euclidean distance (Clifford and Stephenson 1975) as the measure of dissimilarity, where:

Clifford and Stephenson

$$D = \left[ \sum_1^n (x_1 - x_2)^2 \right]^{1/2}$$

$D$  = Euclidean distance between two entities  
 $x_1$  = score for one entity  
 $x_2$  = score for other entity  
 $n$  = number of attributes

The second procedure, referred to as sorting, clusters the entities into a dendrogram based on their dissimilarity. The group average sorting strategy was used in construction of the dendrogram (Boesch 1977). In step three, the dendrograms from both the site and species classifications are combined into a two-way coincidence table. The relative abundance values of each species are replaced by symbols (Smith 1976) and entered into the table. In the event of extreme high abundance of a single species, abundance data are transformed using a natural log transformation [ $\ln(x)$ ].

## DETECTION LIMITS

Detection limits (DL) used in reporting chemistry results are interpreted as the smallest amount of a given analyte that can be measured above the random noise inherent in any analytical tool. Thus, any value below the DL cannot be considered a reliable estimate of analyte concentration. Therefore, where a test for a given analyte results in a level below the DL, a "none detected" (ND) value has been assigned. The complication of what numerical value to substitute for ND in statistical calculations is addressed by EPA (1989, Section 5.3.3). When values for a given analyte are ND for all stations, then means and standard deviations will also be considered ND. However, when an analyte is detected at some stations and not at others, statistical calculations can be made by substituting ND values with either (a) zero, (b) one-half the average detection limit, or (c) the average detection limit (EPA 1989). Determining which substitution to use is based on whether or not substantial information exists to support the historical presence or absence of a given analyte at the station location. Since chemistry analyses have repeatedly resulted in ND values at the same stations through past surveys, ND values have been replaced with zeros in performing statistical calculations. This decision is also based on the fact that detection limits differ in virtually all past surveys, which would confound any yearly comparison if options (b) or (c), from above, are used. Historical raw data are presented in the appendices for possible supplementary study.

## RESULTS

### FIELD OPERATIONS

The 2001 NPDES surveys for the Reliant Energy Mandalay generating station were conducted on 2, 3 and 16 April, 24, 25 and 26 July, and 19 October 2001. Latitude and longitude coordinates for all receiving water (RW) and benthic (B) stations are listed in Table 1.

In winter, water quality data were collected at Stations RW1 through RW17 during two tidal periods on 2 April. At surf-zone Stations RW1 through RW5, ebb tide was sampled between 0920 and 1050 hours (hr), and flood tide between 1300 and 1410 hr (Figure 6). At offshore Stations RW6 through RW17, ebb tide was sampled between 1045 and 1215 hr, and flood tide between 1310 and 1440 hr. On the day of sampling, the tide fell from a high of +4.7 ft Mean Lower Low Water (MLLW) at 0451 hr to a low of -0.3 ft MLLW at 1236 hr, then rose to a high of +3.7 ft MLLW at 1928 hr. Skies changed from mostly cloudy to partly cloudy during the day. Winds increased from west 8 to 15 kn, with a west 2 to 4 ft swell.

Winter otter trawl sampling was conducted on two separate days; at Stations T2, T3, and T4 trawling was conducted between 0900 and 1145 hr on 3 April, and at Station T1 trawling occurred between 0945 and 1100 hr on 16 April. Due to rough weather on 3 April, and the close proximity of the stations to the beach, only three stations were sampled before sampling had to be postponed. On 3 April, skies were overcast, with rain intermittent. Winds changed from calm to greater than 18 kn from the west. The swell was west 2 to 6 ft throughout sampling. On 16 April, the sky was clear, winds southwest 6 to 10 kn, with southwest 2 ft swells.

Summer water quality data were collected at Stations RW1 through RW17 during two tidal periods on 24 July. At surf-zone Stations RW1 through RW5, flood tide was sampled between 1115 and 1210 hr, and ebb tide between 1420 and 1520 hr (Figure 7). At offshore Stations RW6 through RW17, flood tide was sampled between 1050 and 1215 hr, and ebb tide between 1415 and 1520 hr. On the day of sampling, the tide rose from a low of -0.5 ft MLLW at 0714 hr to a high of +4.7 ft MLLW at 1344 hr, then fell to a low of +1.9 ft MLLW at 1923 hr. Skies changed from overcast to clear during sampling. The wind was calm to west 15 kn and seas were 1 to 4 ft from the west-southwest.

Sediment cores were collected by biologist-divers for infaunal analysis, sediment grain size, and sediment chemistry on 25 July between 0825 and 1040 hr. During benthic sampling, skies were overcast with calm to west winds of 2 kn, and seas were from the west at 1 to 2 ft.

Summer otter trawl sampling was conducted between 0735 and 1220 hr on 26 July. Skies were overcast, and winds were west 2 kn during sampling. The swell was west 1 to 2 ft throughout the survey.

A mooring was deployed offshore of the generating station discharge on 25 July. Cages containing mussels were attached to the mooring, for monitoring of metals bioaccumulation. On

**Table 1. Latitude/longitude coordinates of sampling stations. Reliant Energy Mandalay generating station NPDES, 2001.**

Stations			
Water Quality	Benthic	Latitude	Longitude
RW6	-	34°12.57'	119°15.80'
RW7	-	34°12.40'	119°15.72'
RW8	-	34°12.20'	119°15.60'
RW9	-	34°12.04'	119°15.51'
RW10	-	34°11.83'	119°15.34'
RW11	B1	34°12.27'	119°15.43'
RW12	B2	34°11.89'	119°15.22'
RW13	B3	34°12.62'	119°15.60'
RW14	B4	34°11.36'	119°14.94'
RW15	B5	34°13.16'	119°15.90'
RW16	-	34°12.46'	119°15.52'
RW17	-	34°12.09'	119°15.32'
Trawl			
Stations	Heading	Latitude	Longitude
T1	140°	34°13.24'	119°15.98'
T2	135°	34°12.48'	119°15.58'
T3	135°	34°12.20'	119°15.38'
T4	151°	34°11.60'	119°15.10'

19 October, the mussels were retrieved and returned to the laboratory for analysis, after approximately three months *in situ*.

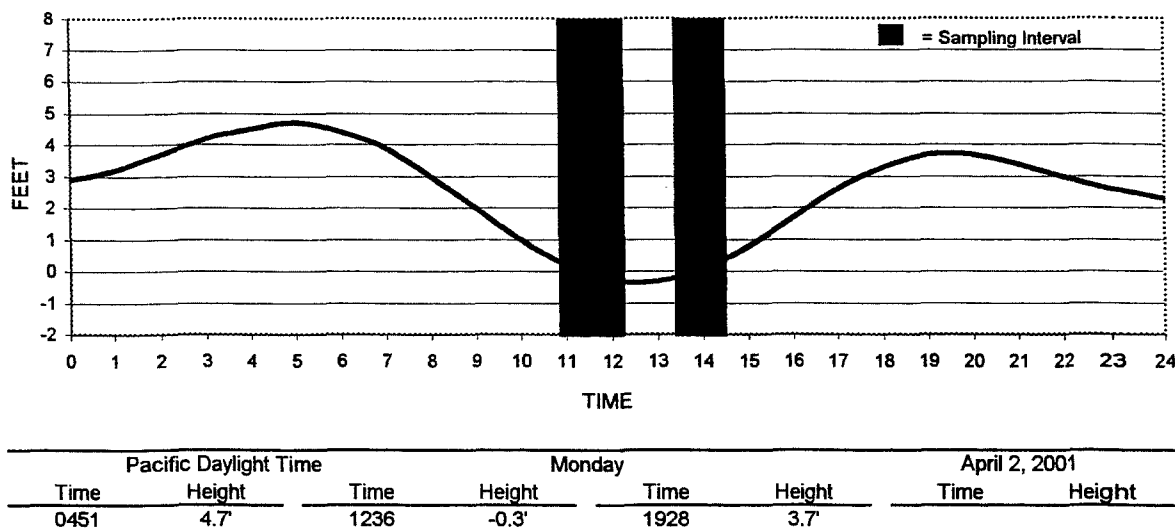


Figure 6. Tidal rhythms during water column sampling, winter survey. Reliant Energy Mandalay generating station NPDES, 2001.

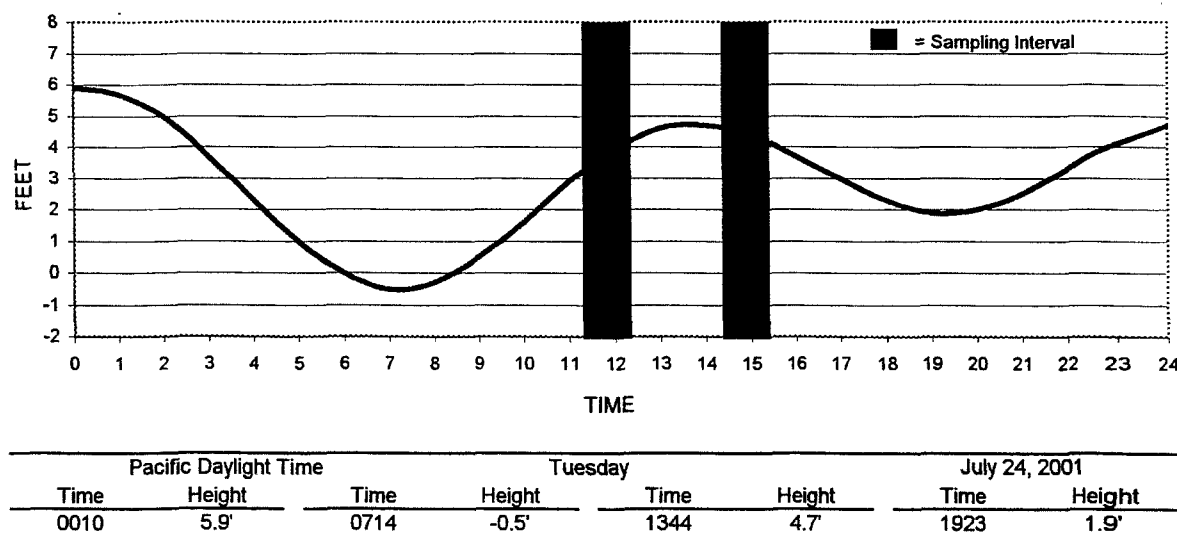


Figure 7. Tidal rhythms during water column sampling, summer survey. Reliant Energy Mandalay generating station NPDES, 2001.

During the winter survey period, no oil films or grease were observed at any of the receiving water or trawl stations. Drift algae or wood were seen at Stations RW8, RW11, and T1. During water quality monitoring, all of the inshore stations were very turbid due to breaking waves and riptides. In the afternoon of 2 April a large plankton bloom (red tide) was present along the beach, beginning at the discharge and stretching about 600 m (2,000 ft) upcoast. Western gulls (*Larus occidentalis*) were seen at Stations RW6, RW8, RW14, RW15, T3, and T4. Unidentified cormorants (*Phalacrocorax* spp.) were seen at Stations RW8, RW10, RW17, and T2. Other less common species seen were: western grebes (*Aechmophorus occidentalis*) at Station T1; a Heermann's gull

(*Larus heermanni*) at Station T1; and a Caspian tern (*Sterna caspia*) at Station T2. On the beach, unidentified gulls (*Larus* sp.) were seen at Stations RW3 and RW5. Dolphins (too far away to identify to genus/species) were seen at Station T1. California brown pelicans (*Pelecanus occidentalis californicus*) were seen at Stations RW11, RW14, T1, T2, and T4. California least terns (*Sterna antillarum browni*) were not observed during any component of the survey.

During the summer survey period no oil, grease, or floatables were observed at any of the receiving water, benthos, or trawl stations. During water quality and benthos sampling the water was a dark brown to green color, with low visibility. A very dark plankton bloom was seen offshore of most of the sampling stations, and at Station RW16 in the morning; in the afternoon most stations were inside the bloom. During benthos and trawl sampling, red tide was noted at Stations B2, B4, and T3. Offshore, during trawl sampling, western gulls, Heermann's gulls, Caspian terns, and unidentified cormorants were seen throughout the study area. During water quality and benthos sampling western gulls were seen at Stations RW12, RW15, and B1; Heermann's gulls at Stations B2 and B4; and Caspian terns at RW9, RW17, B1, and B4. Double-crested cormorants (*Phalacrocorax auritus*) were seen at Stations RW11, RW14, RW17, B2, and T2; a western grebe at Station B1; Forster's terns (*Sterna forsteri*) at Stations T1 and T2; and unidentified terns (*Sterna* spp.) at Stations RW15 and RW16. At surf-zone stations, western gulls and Heermann's gulls were seen at most stations; willets (*Catoptrophorus semipalmatus*) were seen at Station RW4; sanderlings (*Calidris alba*) at Stations RW1 and RW3; and whimbrels (*Numenius phaeopus*) at Stations RW1 and RW3. Common dolphins (*Delphinus delphis*) were seen at Station RW12; unidentified dolphins (too far away to identify to genus/species) were seen at Stations B2 and B5; and bottlenose dolphins (*Tursiops truncatus*) were seen at Station T3. California sea lions (*Zalophus californianus*) were seen at Stations T2 and T4. California brown pelicans were seen throughout the study area during benthos and trawl sampling; on 24 and 25 July they were seen at Stations RW10, RW14, RW15, B1, B2, and B4. California least terns were seen offshore at Station T3; on the beach about 100 were seen at Station RW3. During trawling, a bait boat was in the vicinity of Station T4 catching bait.

## WATER COLUMN MONITORING

Water quality data for ebb and flood tides are summarized in Figures 8 through 12, and Tables 2 and 3. Raw data are presented in Appendix C.

### Temperature

During winter sampling, surface water temperatures at offshore stations averaged 15.48°C during ebb tide and 16.0°C during flood (Table 2). On the morning ebb tide, surface temperatures

Table 2. Summary of water quality parameters during ebb and flood tides at offshore stations. Reliant Energy Mandalay generating station NPDES, 2001.

	Temp. (°C)		D.O. (mg/l)		pH		Salinity (ppt)		Temp. (°C)		D.O. (mg/l)		pH		Salinity (ppt)	
Winter																
	Surface								Bottom							
	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood
Mean	15.48	16.00	8.59	8.44	8.02	8.01	32.59	32.71	14.51	14.45	8.80	8.70	8.02	8.02	33.34	33.36
Minimum	15.02	15.27	8.34	7.90	8.00	7.99	31.90	32.16	14.31	14.25	8.63	8.52	8.00	8.00	33.21	33.28
Maximum	16.20	18.18	8.80	8.80	8.03	8.04	33.16	33.09	14.86	14.75	8.94	8.82	8.04	8.03	33.43	33.39
Summer																
	Surface								Bottom							
	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood
Mean	16.57	14.98	9.43	6.61	8.14	7.92	33.49	33.48	13.97	13.36	7.35	5.80	7.88	7.80	33.61	33.52
Minimum	16.37	14.30	8.78	5.91	8.11	7.84	33.47	33.34	13.06	13.09	6.09	5.20	7.79	7.75	33.52	33.41
Maximum	16.81	15.42	10.47	7.82	8.20	8.04	33.50	33.52	15.44	14.11	9.12	6.57	8.00	7.88	33.91	33.54

ranged from 15.02°C at Station RW13, upcoast of the discharge on the 30-ft isobath, to 16.20°C at Station RW11, directly offshore of the discharge on the 20-ft isobath. Surface temperatures during flood tide ranged from 15.27°C at Station RW10, downcoast of the discharge channel on the 30-ft isobath, to 18.18°C at Station RW16, just upcoast of the discharge on the 20-ft isobath. Surface water temperatures during the afternoon flood tide were slightly higher than during ebb tide at all but two stations (Figure 8). During flood tide, relatively sharp thermoclines were present at two to four meters depth at Stations RW8 and RW9, offshore of the discharge on the 30-ft isobath, and at

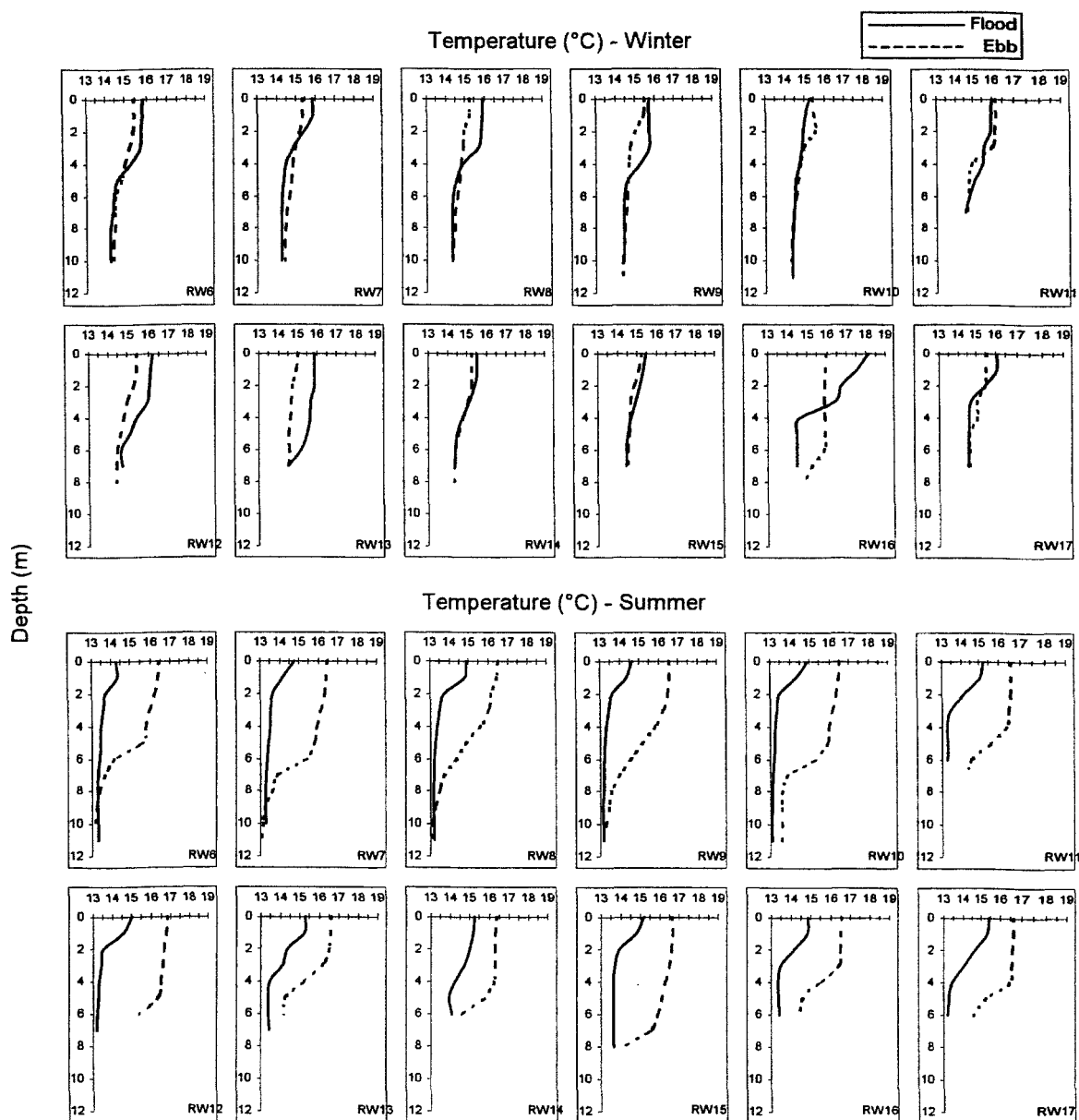


Figure 8. Temperature vertical profiles during ebb and flood tides. Reliant Energy Mandalay generating station NPDES, 2001.

Stations RW16 and RW17, upcoast and downcoast of the discharge on the 20-ft isobath. During ebb tide, slight thermoclines were present at Stations RW10 and RW11 at 1 to 3 m depth, and at RW16 at 6 m depth. The water column was generally well-mixed at most stations with slight decreases in

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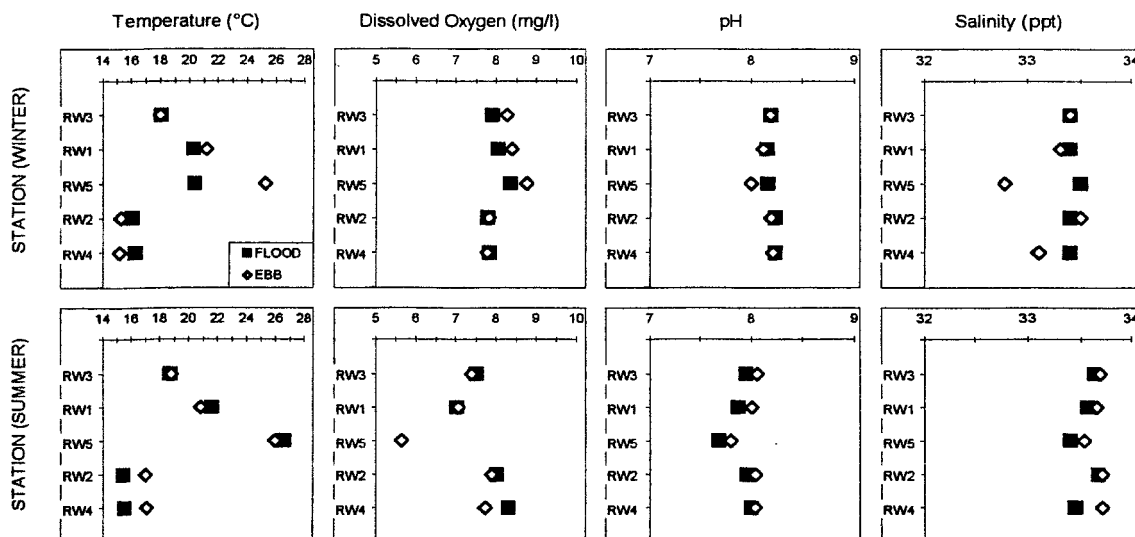
temperature to the bottom. Near-bottom temperatures averaged 14.45°C and 14.51°C during flood and ebb tide, respectively. The maximum surface-to-bottom temperature differentials were 3.70°C at Station RW16, upcoast of the discharge on the 20-ft isobath, on flood tide, and 1.50°C at Station RW11, directly offshore of the discharge on the 20-ft isobath, during ebb tide (Appendix C-1).

Temperatures at surf-zone stations in winter averaged 18.24°C during flood tide and 19.00°C during ebb tide (Table 3 and Figure 9). The highest temperature during each tide was recorded at Station RW5 at the discharge channel. Temperatures at the surf-zone stations were on average 2 to 3.5°C higher than surface values recorded at offshore stations.

**Table 3. Summary of water quality parameters during ebb and flood tides at surf-zone stations. Reliant Energy Mandalay generating station NPDES, 2001.**

	Temp. (°C)		D.O. (mg/l)		pH		Salinity (ppt)		Temp. (°C)		D.O. (mg/l)		pH		Salinity (ppt)	
	Winter								Summer							
	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood
Mean	19.00	18.24	8.21	7.99	8.15	8.20	33.22	33.42	19.95	19.61	7.15	7.15	7.99	7.90	33.66	33.54
Minimum	15.20	16.10	7.78	7.79	8.00	8.16	32.80	33.40	17.03	15.48	5.65	4.85	7.80	7.69	33.53	33.40
Maximum	25.30	20.40	8.76	8.37	8.22	8.24	33.50	33.50	25.99	26.61	7.89	8.31	8.06	8.00	33.71	33.67
RW1	21.20	20.30	8.40	8.04	8.12	8.16	33.30	33.40	20.84	21.65	7.06	7.03	8.01	7.88	33.66	33.57
RW2	15.30	16.10	7.83	7.79	8.20	8.24	33.50	33.40	17.03	15.48	7.89	8.02	8.04	7.96	33.71	33.67
RW3	18.00	18.10	8.27	7.91	8.19	8.20	33.40	33.40	18.80	18.75	7.40	7.52	8.06	7.95	33.69	33.63
RW4	15.20	16.30	7.78	7.84	8.22	8.24	33.10	33.40	17.11	15.56	7.73	8.31	8.04	8.00	33.71	33.45
RW5	25.30	20.40	8.76	8.37	8.00	8.17	32.80	33.50	25.99	26.61	5.65	4.85	7.80	7.69	33.53	33.40

During summer sampling, surface water temperature at offshore stations averaged 16.57°C during afternoon ebb tide and 14.98°C during morning flood tide (Table 2 and Appendix C-2). Surface temperatures during the ebb tide ranged from 16.37°C at Station RW14 to 16.81°C at Station RW12, downcoast of the discharge on the 20-ft isobath. During flood tide, surface water temperatures ranged from 14.30°C at Station RW6, farthest upcoast of the discharge on the 30-ft isobath, to 15.42°C at Station RW17, just downcoast of the discharge on the 20-ft isobath. Surface



**Figure 9. Surf-zone water quality parameters during ebb and flood tides. Reliant Energy Mandalay generating station NPDES, 2001.**

water temperatures were higher on ebb tide at all stations (Figure 8). During both flood and ebb tides, temperatures dropped rapidly with depth, with thermoclines present from near one to four meters depth at most stations on flood tide and at 4 to 8 m on ebb tide. Near-bottom temperatures averaged 13.97°C during ebb tide and 13.36°C during flood tide. The maximum surface-to-bottom temperature differential was 3.43°C at Stations RW7 and RW8 on ebb tide, and 2.21°C at Station RW17 during flood tide.

Temperatures at surf-zone stations in summer averaged 19.95°C during ebb tide and 19.61°C during flood tide (Table 3 and Figure 9). On both tides, the high temperature recorded at the discharge channel was 4 to 10°C higher than the lowest shoreline surface temperature. Temperatures on both ebb and flood tide at Stations RW1 and RW3, upcoast from the discharge channel, were several degrees higher than surface temperatures at offshore stations. Temperatures at Stations RW2 and RW4, downcoast of the discharge channel, more closely resembled surface values recorded at offshore stations.

### Dissolved Oxygen

Surface DO concentrations at offshore stations in winter averaged 8.44 mg/l during flood tide and 8.59 mg/l during ebb tide (Table 2). Concentrations during flood tide ranged from 7.90 mg/l at Station RW16, just upcoast of the discharge on the 20-ft isobath, to 8.80 mg/l at Station RW10; during ebb tide DO concentrations ranged from 8.34 mg/l at Station RW11 to 8.80 mg/l at Stations RW13 and RW15. Dissolved oxygen profiles were similar between tides, although values were generally slightly higher during ebb tide (Figure 10, Appendix C-1). Dissolved oxygen concentration values during both tides generally fluctuated but increased slightly to a depth of 6 to 8 m, then decreased to the bottom. The largest surface-to-bottom DO concentration differentials were found at the stations at or upcoast of the discharge along the 20-ft isobath, 0.91 mg/l at Station RW16 on flood tide and 0.60 mg/l at Station RW11 on ebb tide. Mean near-bottom DO levels were 8.70 mg/l during flood tide and 8.80 mg/l during ebb tide.

Dissolved oxygen concentrations at surf-zone stations in winter averaged 8.21 mg/l during ebb tide and 7.99 mg/l during flood tide (Table 3, Figure 9). During flood tide, DO concentrations ranged from 7.79 mg/l at Station RW2 to 8.37 mg/l at discharge channel Station RW5. During ebb tide, DO concentrations ranged from 7.78 mg/l at Station RW4 to 8.76 mg/l, again at Station RW5.

Summer surface DO concentrations at offshore stations averaged 9.43 mg/l during afternoon ebb tide and 6.61 mg/l during morning flood tide (Table 2). Concentrations during ebb tide ranged from 8.78 mg/l at Station RW6 to 10.47 mg/l at Station RW9; during flood tide concentrations ranged from 5.91 mg/l at Station RW7 to 7.82 mg/l at Station RW14, the downcoast control station on the 20-ft isobath. Surface DO concentrations were higher during the midday ebb tide than on the earlier flood tide, with a maximum increase between tides of 4.14 mg/l at Station RW9 (Appendix C-2). Dissolved oxygen concentrations generally increased slightly on both tides to a subsurface maximum at 1 to 3 m depth (Figure 10). Below the subsurface maxima, DO decreased with depth. The greatest surface-to-bottom DO concentration differential was 1.34 mg/l at Station RW15 during flood tide and 4.16 mg/l at Station RW9 during ebb tide. Mean near-bottom DO levels were 7.35 mg/l during ebb tide and 5.80 mg/l during flood tide.

Dissolved oxygen concentrations at surf-zone stations in summer averaged 7.15 mg/l during both tides (Table 3 and Figure 9). During ebb tide, DO concentrations ranged from 5.65 mg/l at Station RW5 to 7.89 mg/l at Station RW2. During flood tide, DO concentrations ranged from 4.85 mg/l at Station RW5 to 8.31 mg/l at Station RW4.

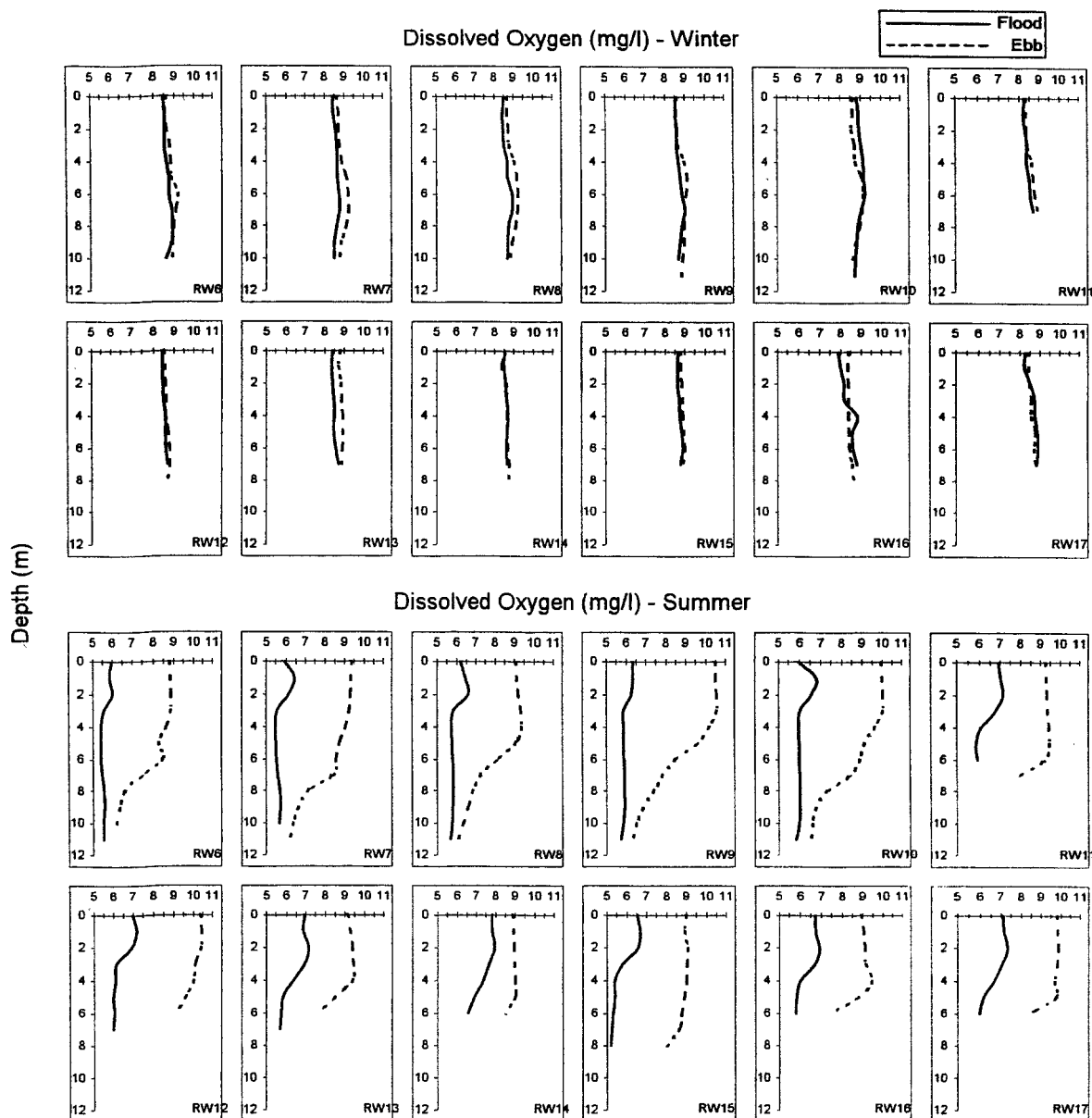


Figure 10. Dissolved oxygen vertical profiles during ebb and flood tides. Reliant Energy Mandalay generating station NPDES, 2001.

#### Hydrogen Ion Concentration

Surface hydrogen ion concentration (pH) in winter at Stations RW6 through RW17 averaged 8.01 on flood tide and 8.02 on ebb tide, and ranged from 7.99 to 8.04 during the survey (Table 2). Water column pH values were similar among the offshore stations, with pH varying by 0.06 or less among stations and between tides (Figure 11, Appendix C-1).

Surf-zone pH in winter averaged 8.20 on flood tide and 8.15 on ebb tide. Surf-zone pH varied by less than 0.24 units, ranging from 8.00 to 8.24 (Table 3 and Figure 9).

In summer, surface hydrogen ion concentration at the offshore stations averaged 8.14 on ebb tide and 7.92 on flood tide, and ranged from 7.84 to 8.20 (Table 2). Water column pH was higher on ebb tide than on flood tide, but pH profiles were relatively similar between stations, with pH varying by 0.09 or less among stations on ebb tide and 0.2 units or less on flood tide (Figure 11, Appendix C-2).

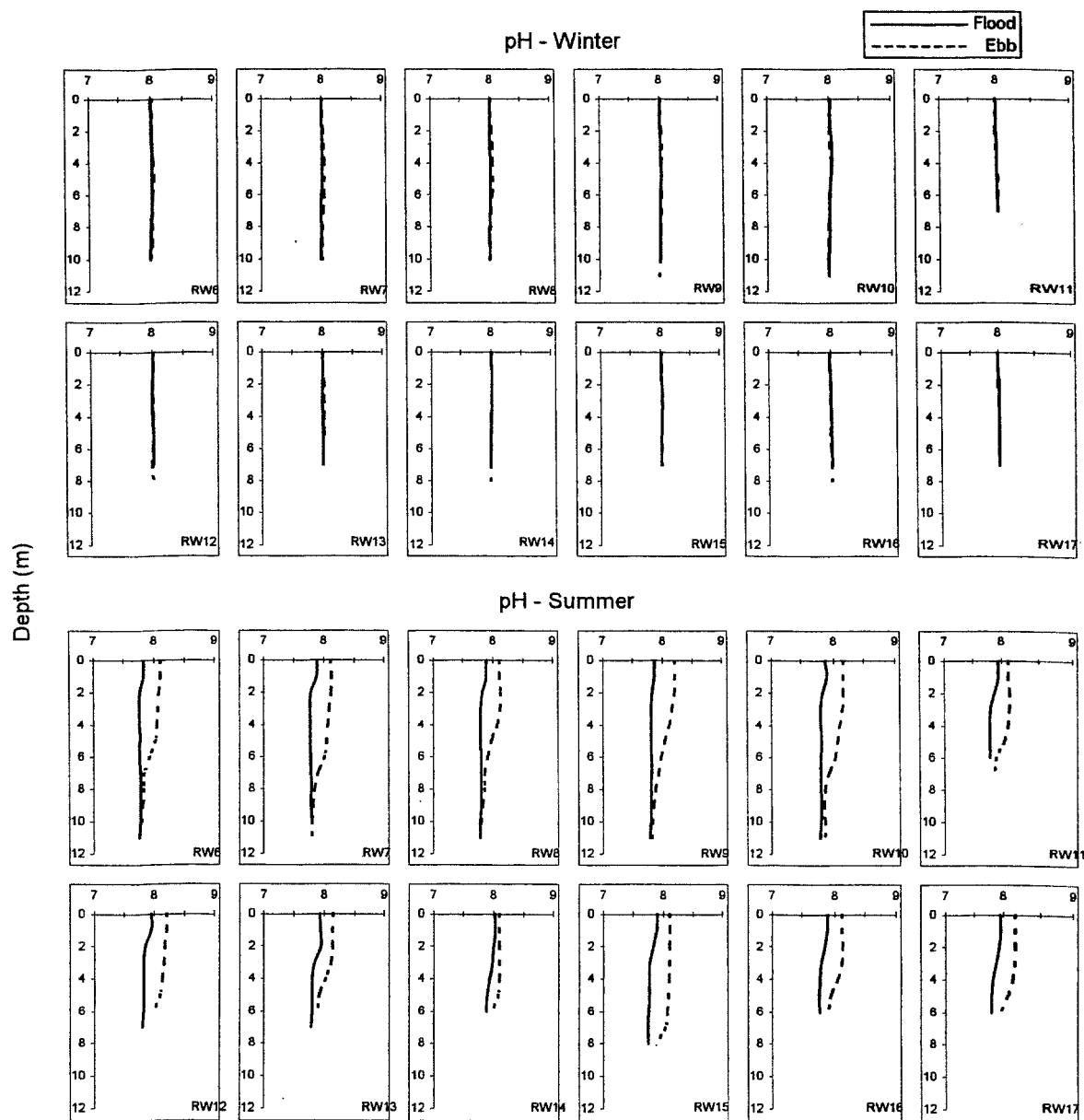


Figure 11. Hydrogen ion concentration (pH) vertical profiles during ebb and flood tides. Reliant Energy Mandalay generating station NPDES, 2001.

Surf-zone pH in summer averaged 7.99 on ebb tide and 7.90 on flood tide. Surf-zone pH varied by less than 0.40 units, and ranged from 7.69 to 8.06 (Table 3 and Figure 9).

## Salinity

In winter, salinity concentration at the surface at offshore stations during ebb tide averaged 32.59 parts per thousand (ppt) and ranged from 31.90 ppt at Station RW10 to 33.16 ppt at Station RW13, and was similar during flood tide, averaging 32.71 ppt with a range 32.16 ppt at Station RW15 to 33.09 ppt at Station RW11 (Table 2). Values generally increased with depth with haloclines at 1 to 5 m at most stations on both tides. The halocline shifted between tides occurring at shallower depths at some stations during ebb tide and deeper at other stations. At a few stations, the profiles were uniform with only slight increases to the bottom (Figure 12). Salinity at the bottom averaged 33.34 ppt on ebb tide and 33.36 ppt on flood tide and varied by 0.22 ppt between tides and among stations.

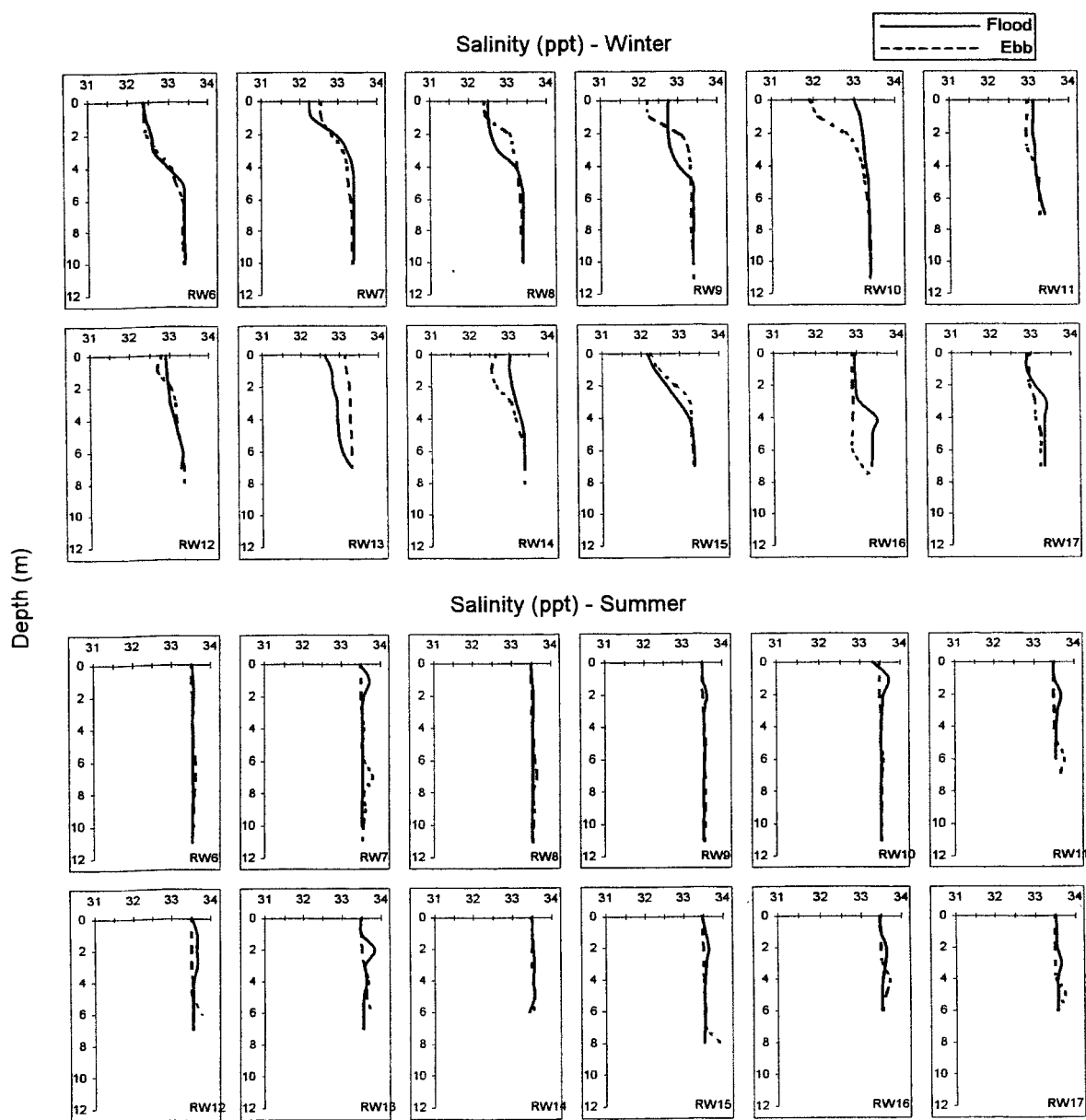


Figure 12. Salinity (ppt) vertical profiles during ebb and flood tides. Reliant Energy Mandalay generating station NPDES, 2001.

In winter, at the shoreline stations, salinity averaged 33.22 ppt on ebb tide and 33.42 ppt on flood tide (Table 3, Figure 9). Ebb tide was more variable with a low of 32.80 ppt at Station RW5 and a high of 33.50 ppt at Station RW2. On flood tide, the variation among stations was 0.1 ppt or less.

In summer, mean surface salinity was 33.49 ppt on ebb tide and nearly identical (33.48 ppt) during flood tide, with values differing from the mean by 0.18 ppt between stations and tides (Table 2). Salinity levels were generally identical through the water column on both tides; however, at some stations slight increases were noted at 1 to 2 m depth on flood tide and a few increases were noted deeper on ebb tide at 4 to 8 m depth (Figure 12). Mean bottom salinity was again nearly identical with ebb tide values of 33.61 ppt and 33.52 ppt on flood tide. A maximum difference of 0.50 ppt was found between tides and among stations.

Summer surf zone salinity values averaged 33.66 ppt on ebb tide and 33.54 ppt on flood tide (Table 3, Figure 9). Ebb tide and flood tide values did not vary by more than 0.21 ppt between tides or among stations.

## SEDIMENT MONITORING

### Sediment Grain Size

Particle size distribution curves for each station are presented in Appendix D and sediment grain size parameters are summarized in Table 4. Grain size is expressed in phi ( $\Phi$ ) units, which are inversely related to grain diameter (Appendix B).

**Table 4. Sediment grain size parameters. Reliant Energy Mandalay generating station NPDES, 2001.**

Parameter	Station					Mean	S.D.
	B1	B2	B3	B4	B5		
% Gravel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Sand	94.78	95.96	96.21	96.92	85.18	93.81	4.89
% Silt	4.52	3.44	2.90	2.41	13.15	5.28	4.47
% Clay	0.70	0.60	0.89	0.67	1.67	0.91	0.44
Mean grain size							
phi	2.47	2.61	2.64	2.63	3.28	2.70	0.32
mm	180	163	161	162	103	153.8	29.5
Sorting ( $\phi$ )	0.71	0.61	0.61	0.57	0.79	0.66	0.09
Skewness	0.18	0.10	0.00	0.02	0.11	0.08	0.07
Kurtosis	1.23	1.18	1.13	1.13	1.46	1.23	0.14

In 2001, sediments in the study area were composed primarily of sand, with smaller amounts of silt and clay (Table 4). Overall, samples from the five stations averaged 94% sand, 5% silt, and 1% clay, with an average mean grain size of 2.70 phi (154  $\mu$ m, fine sand). Sediments were finest at Station B5 (furthest upcoast), where mean grain size was 3.28 phi (103  $\mu$ m, very fine sand). Coarsest sediments were collected at Station B1 (off the discharge canal), where mean grain size was 2.47 phi (180  $\mu$ m, fine sand). The percentage of fine material (silt and clay) in sediments ranged from 3.1% at Station B4 to 14.8% at Station B5. Particle size distribution, as well as all other grain size parameters, was similar among Stations B2, B3, and B4.

Sorting, a measure of the spread of the particle distribution curve, averaged 0.66 phi overall, indicating moderately well sorted sediments (Table 4). Sorting values ranged from 0.57 phi (moderately well sorted) at Station B4, downcoast from the discharge canal, to 0.79 phi (moderately sorted) at Station B5. Poorly sorted sediments are composed of a broad range of particle sizes, while well sorted sediments contain only a few size classes.

Skewness and kurtosis tell how closely the grain size distribution curve approaches the normal Gaussian probability curve. More extreme skewness and kurtosis values indicate non-normal

distributions. Skewness is a measure of the symmetry of the particle distribution curve; a value of zero indicates a symmetrical distribution of fine and coarse materials around the mode of the curve, while a value greater than zero (positive) indicates an excess of fine material, and a negative value indicates an excess of coarse material. Aside from Station B3 where skewness was zero, sediments at the other four stations were positively skewed, indicating a slightly greater amount of fine material in the sediments (Table 4). The greatest skewness was 0.18, recorded at Station B1.

Kurtosis is a measure of the peakedness of the particle distribution curve. A kurtosis value of 1.00 represents a normal particle distribution curve. In 2001, kurtosis values at all stations were greater than 1.00, indicating leptokurtic (excessively peaked) distributions, with dominance by a narrow range of particle sizes (Table 4). Kurtosis ranged from 1.13 at Stations B3 and B4 to 1.46 at Station B5.

### Sediment Chemistry

Sediment samples collected at benthic stations were analyzed for chromium, copper, nickel, and zinc. Values are reported as dry weight. Although concentrations of all metals were highest at Station B4, the downcoast control station, values were similar among stations (Table 5, Appendix E). Lowest concentrations of chromium and nickel occurred at Station B5, and lowest copper concentration occurred at Station B2. Lowest zinc concentration occurred at Stations B2 and B5.

**Chromium.** Sediment chromium concentrations averaged 10.4 mg/kg and ranged from 8.3 mg/kg at Station B5 to 13 mg/kg at Station B4 (Table 5).

**Copper.** Sediment copper concentrations averaged 2.6 mg/kg and ranged from 2.3 mg/kg at Station B2 to 2.8 mg/kg at Station B4 (Table 5).

**Nickel.** Sediment nickel concentrations averaged 6.7 mg/kg and ranged from 6.0 mg/kg at Station B5 to 8.0 mg/kg at Station B4 (Table 5).

**Zinc.** Sediment zinc concentrations averaged 20 mg/kg and ranged from 18 mg/kg at Stations B2 and B5 to 23 mg/kg at Station B4 (Table 5).

Table 5. Concentration of metals (mg/dry kg) in sediments. Reliant Energy Mandalay generating station NPDES, 2001.

Metal	Station					Overall		ERL	Detection Level
	B1	B2	B3	B4	B5	Mean	S.D.		
Chromium	11	8.9	11	13	8.3	10.4	1.9	81	1.4 - 1.8
Copper	2.5	2.3	2.6	2.8	2.6	2.6	0.2	34	1.4 - 1.8
Nickel	6.7	6.3	6.7	8.0	6.0	6.7	0.8	21	1.4 - 1.8
Zinc	21	18	20	23	18	20	2.1	150	7.2 - 9.1

### MUSSEL BIOACCUMULATION

In 2001, forty-four (44) bay mussels (*Mytilus edulis*) were collected at the west end of Catalina Island and outplanted offshore of the Mandalay generating station discharge structure for a period of 90 days to bioaccumulate. An additional 43 mussels, collected from the same location at Catalina Island, were tested immediately for the metals chromium, copper, nickel, and zinc.

Copper and zinc were detected in all replicates at both Catalina and at the Mandalay generating station, while none of the replicates for nickel or chromium were above detection limits (Table 6 and Appendix F). Mean concentration of copper was 10.7 mg/dry kg with a range of 7 to 13 mg/dry kg at Mandalay and 15 mg/dry kg at Catalina with a range of 13 to 16 mg/dry kg. Mean concentration of zinc was 177 mg/dry kg at Mandalay and 230 mg/dry kg at Catalina Island. Both

areas had similar ranges of zinc levels of 130 to 260 mg/dry kg and 170 to 270 mg/dry kg, respectively.

**Table 6. Bay mussel tissue metal concentrations (mg/dry kg). Reliant Energy Mandalay generating station NPDES, 2001.**

Metal	Replicate			Mean	S.D.	ERL	Detection Limit
	1	2	3				
Mussel Mooring							
Chromium	ND	ND	ND	ND	-	81	5.5 - 6.3
Copper	12	13	7.0	10.7	3.2	34	5.5 - 6.3
Nickel	ND	ND	ND	ND	-	21	5.5 - 6.3
Zinc	130	260	140	177	72.3	150	28 - 32
Catalina (west end) Reference Site							
Chromium	ND	ND	ND	ND	-	81	7.4 - 9.5
Copper	13	16	16	15	1.7	34	7.4 - 9.5
Nickel	ND	ND	ND	ND	-	21	7.4 - 9.5
Zinc	270	170	250	230	52.9	150	170 - 270

ND = Below the detection limit (for calculations ND = 0)

ERL = Effects Range Low

## BIOLOGICAL MONITORING

### Benthic Infauna

Results of the infauna sampling in 2001 are presented by station in Appendix G. Data are summarized in Tables 7, 8 and 9 and in Figure 13.

**Species Composition.** In 2001, the infauna samples from the five benthic stations contained a total of 1,161 individuals representing 75 species in eight phyla (Table 7). Annelids (segmented worms), arthropods, and mollusks were the most abundant and speciose phyla (major taxonomic groups), comprising almost 69%, 17%, and 6% of the individuals, and 41%, 28%, and 19% of the species collected, respectively. Annelids were the most abundant group at all stations except Station B4 (farthest downcoast), ranging from 25% of the individuals at Station B4 to 86% of the individuals at Station B2 (immediately downcoast of the discharge). Arthropods were almost twice as abundant as annelids at Station B4, comprising 48% of the community. Annelids were the most speciose phylum at all five stations. The phyla Cnidaria (sea anemones), Nematoda (round worms), and Phoronida (phoronid worms) were represented by only one species each.

**Abundance.** Abundance at the five stations averaged 232 individuals (58 individuals per replicate, or 5,808 individuals/m<sup>2</sup>), ranging from 39 individuals at Station B3, immediately upcoast of the discharge, to 423 individuals at Station B2 (Table 8). Abundance at the discharge (Station B1) was above the average for the study area.

**Species Richness.** A total of 75 infauna species were collected, with an average of 29 species per station (Table 8). Species richness ranged from 17 species at Station B3 to 40 species at Station B5, farthest upcoast. At Station B1, 32 species were taken, slightly above the study-area average.

**Species Diversity (H').** Shannon-Weiner species diversity averaged 2.06 per station and ranged from 1.14 at Station B2 to 2.77 at Station B5 (Table 8). Diversity at Station B1, 1.59, was lower than the station average. The low diversity values at Stations B1 and B2 were due to the high abundance of one species.

**Biomass.** Biomass averaged 43.32 g per station (1,083 g/m<sup>2</sup>) and ranged from 0.83 g (29 g/m<sup>2</sup>) at Station B3 to 116.79 g (2,920 g/m<sup>2</sup>) at Station B4 (Table 8). At Station B1, biomass was 14.64 g, about one-third of the five-station average. Pacific sand dollars (*Dendraster excentricus*) contributed 95% of the biomass (Appendix G-4). Large sand dollars occurred at all stations except

Station B3. They were particularly abundant at Stations B4 and B5, averaging 575 individuals/m<sup>2</sup> and 325 individuals/m<sup>2</sup>, respectively.

**Table 7. Number of infaunal species and individuals by phylum. Reliant Energy Mandalay generating station NPDES, 2001.**

Parameter	Station					Total	Percent Total
	B1	B2	B3	B4	B5		
Number of species							
Annelida	13	15	10	8	17	31	41.3
Arthropoda	9	9	3	5	10	21	28.0
Mollusca	6	5	1	4	7	14	18.7
Nemertea	2	3	2	2	3	4	5.3
Echinodermata	2	2	1	2	1	2	2.7
Cnidaria	-	-	-	-	1	1	1.3
Nematoda	-	-	-	1	-	1	1.3
Phorona	-	-	-	-	1	1	1.3
Total	32	34	17	22	40	75	
Number of individuals							
Annelida	208	365	20	31	173	797	68.6
Arthropoda	59	24	8	58	53	202	17.4
Mollusca	9	17	1	5	39	71	6.1
Echinodermata	3	3	1	24	13	44	3.8
Nemertea	5	14	9	3	9	40	3.4
Cnidaria	-	-	-	-	4	4	0.3
Phorona	-	-	-	-	2	2	0.2
Nematoda	-	-	-	1	-	1	0.1
Total	284	423	39	122	293	1161	

**Table 8. Infaunal community parameters. Reliant Energy Mandalay generating station NPDES, 2001.**

	Station						
Parameter	B1	B2	B3	B4	B5	Total	Mean
Number of species							
Total	32	34	17	22	40	75	29
Rep. Mean	13.0	14.0	6.8	10.3	20.8		
Rep. S.D.	2.4	3.4	2.1	4.0	6.3		
Number of individuals							
Total	284	423	39	122	293	1161	232.2
Rep. Mean	71.0	105.8	9.8	30.5	73.3	58.1	
Rep. S.D.	19.5	27.1	3.9	5.1	16.6		
Density (#/m <sup>2</sup> )							5808
Diversity (H')							
Total	1.59	1.14	2.56	2.28	2.77	2.39	2.06
Rep. Mean	1.33	1.01	1.74	1.92	2.36		
Rep. S.D.	0.20	0.25	0.26	0.40	0.30		
Biomass (g)							
Total	14.637	6.317	0.831	116.791	78.026	216.602	43.320
Rep. Mean	3.659	1.579	0.208	29.198	19.507		
Rep. S.D.	6.798	2.369	0.211	11.193	4.083		

**Community Composition.** The most abundant species were used to characterize the infauna community. Eleven species each represented 1.0% or more of the individuals in the infauna collection (Table 9, Appendix G-2). These 11 species together comprised only 15% of the species

taken but almost 83% of the individuals. Four of these species, including three of the five most abundant, occurred at all stations, while five species were present at four of the five stations. One of the top 11 species occurred at only one station (Station B5), and one species occurred at only two stations (Stations B2 and B5). These two species were the only ones among the top 11 that did not occur at Station B1.

Table 9. The 11 most abundant infaunal species. Reliant Energy Mandalay generating station NPDES, 2001.

Phylum Species	Station					Percent Cum.	
	B1	B2	B3	B4	B5	Total	Total Percent
AN <i>Apoprionospio pygmaea</i>	186	337	2	9	35	569	49.0
AN <i>Mediomastus acutus</i>	3	1	3	-	96	103	8.9
AR <i>Americhelidium shoemakeri</i>	17	9	-	31	11	68	5.9
AR <i>Rhepoxynius menziesi</i>	27	3	4	23	10	67	5.8
EC <i>Dendraster excentricus</i>	2	2	1	23	13	41	3.5
NE <i>Carinoma mutabilis</i>	4	10	8	2	5	29	2.5
AN <i>Scoloplos armiger</i> Cmplx	4	4	3	9	-	20	1.7
MO <i>Tellina modesta</i>	3	4	-	2	11	20	1.7
MO <i>Siliqua lucida</i>	2	10	-	1	4	17	1.5
MO <i>Mactromeris catilliformis</i>	-	-	-	-	14	14	1.2
AR <i>Rhepoxynius</i> sp A SCAMIT 1987	-	1	-	-	11	12	1.0

AN = Annelida; AR = Arthropoda; EC = Echinodermata; NE = Nemertea; MO = Mollusca

Three of the 11 most abundant species, including the top two, were annelids, less than the proportion of annelid species in the total collection (Table 9). Three arthropod species, three mollusk species, and one each of echinoderm and nemertean were among the top 11 species. The most abundant species was the polychaete annelid *Apoprionospio pygmaea*, which comprised 49% of all individuals collected. The polychaete *Mediomastus acutus* was second most abundant, comprising just under 9% of the individuals, followed by the amphipods *Americhelidium shoemakeri* and *Rhepoxynius menziesi* (6% each), and *Dendraster excentricus* (4%). These five species included almost three-quarters of all individuals collected. Other top species, although less abundant overall, were relatively abundant at one or another of the stations. The nemertean worm *Carinoma mutabilis* was the most abundant species at Station B3, and *Carinoma* and the clam *Siliqua lucida* ranked second in abundance at Station B2.

**Cluster Analyses.** Normal (station) and inverse (species) cluster analyses were performed on the 11 most abundant species in the infauna data (Table 9).

The five stations clustered into two groups, based on their relative abundances of the 11 most abundant species (Figure 13). The communities in Station Group I (Stations B1 through B4) were more similar to each other than to the community at Station B5 (Group II). Stations B1 and B2 clustered most closely, because of the similarity of community composition and abundance of the numerically dominant species. Stations B4 and B3 clustered next most closely to Stations B1 and B2, but more distantly from the latter group than to each other. Station B5 clustered last, due to a more even distribution of the community dominants. However, it actually clustered as closely to the other four stations as Station B3 to Station B4, and more closely than Station B4 to Stations B1 and B2. The top 11 species divided into three groups, based on their similarity of occurrence. *Apoprionospio pygmaea* (Species Group A) was the overwhelmingly most abundant species and occurred at all five stations. Group B included those species that were next most abundant and occurred at all or most of the stations. Species in Group C were those that occurred exclusively at or were most abundant at Station B5.

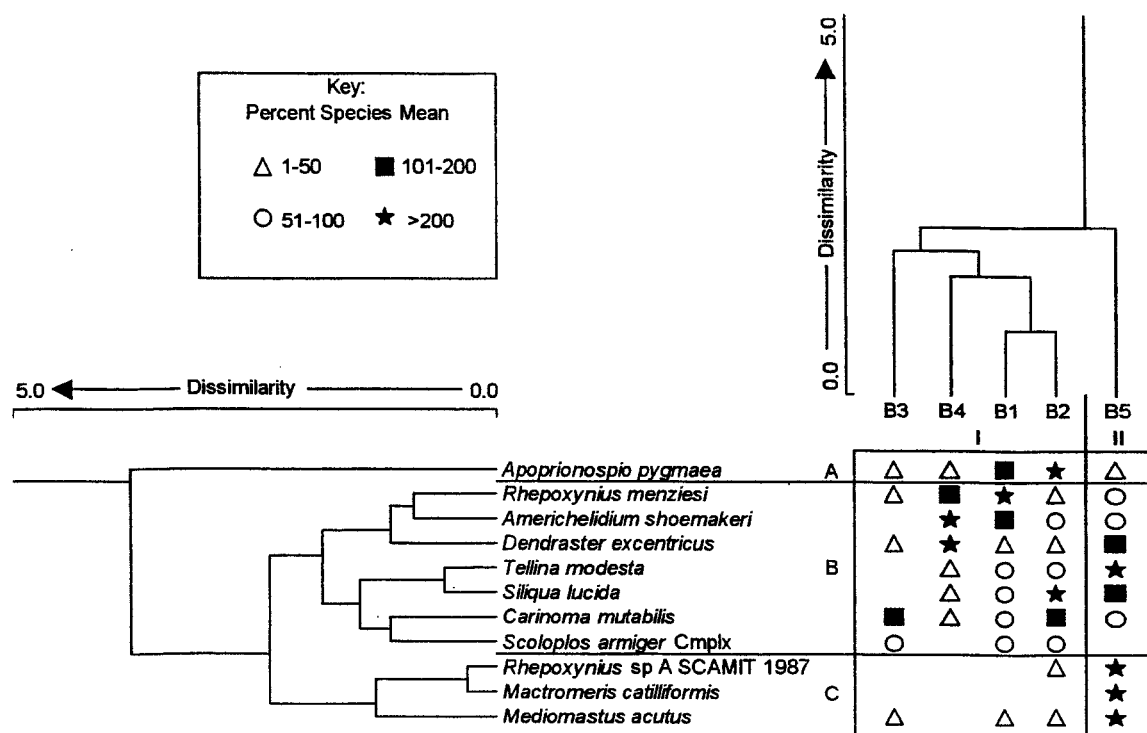


Figure 13. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 11 most abundant infaunal species. Reliant Energy Mandalay generating station NPDES, 2001.

### Fish and Macroinvertebrates

Demersal fish surveys were performed on 16 April (winter) and 26 July 2001 (summer). Complete otter trawl data are presented in Appendix H. Data for both fish and macroinvertebrates are summarized separately in tables and figures for fish and macroinvertebrates.

#### Fish

**Species Composition.** The winter and summer trawl surveys yielded 24 species of fish, including four families and four species of cartilaginous fish (Elasmobranchiomorphi or Chondrichthyes) and 11 families and 20 species of bony fish (Osteichthyes) (Appendix H-1). The most diverse fish families were Sciaenidae (croakers) and Embiotocidae (surfperches), each represented by four species.

Queenfish (*Serphus politus*), white croaker (*Genyonemus lineatus*), and northern anchovy (*Engraulis mordax*) were the most abundant fish species collected in the study area, and were found at all four trawl stations during both surveys (Table 10). White croaker was the most abundant species in winter, while queenfish dominated the catch in summer. In winter, speckled sanddab (*Citharichthys stigmaeus*), kelp pipefish (*Syngnathus leptorhynchus*), and barred surfperch (*Amphistichus argenteus*), which ranked fourth, fifth, and tenth in abundance, respectively, were collected at all four stations. California corbina (*Menticirrhus undulatus*) and thornback (*Platyrrhinoidis triseriata*) were collected at three stations in winter, while the remaining five species were found at only one or two trawl stations. In summer, kelp pipefish, walleye surfperch (*Hyperprosopon argenteum*), and California lizardfish (*Synodus lucioceps*), which ranked fourth, sixth, and seventh, respectively, were collected at all four stations. Shiner perch (*Cymatogaster aggregata*) was

collected at three stations in summer, while the remaining 15 species were found at only one or two trawl stations.

**Table 10. Abundance and catch parameters for fish species taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Winter					Summer					Total
	T1	T2	T3	T4	Total	T1	T2	T3	T4	Total	
queenfish	495	212	8	67	782	96	695	2715	342	3848	4630
white croaker	485	246	3	172	906	53	41	30	3	127	1033
northern anchovy	72	36	23	14	145	185	33	11	9	238	383
kelp pipefish	14	3	1	7	25	46	24	8	1	79	104
speckled sanddab	2	12	2	14	30	-	-	4	4	8	38
walleye surfperch	-	-	-	-	-	2	2	23	10	37	37
California lizardfish	-	-	2	3	5	3	3	13	2	21	26
California corbina	3	10	-	10	23	-	-	1	-	1	24
shiner perch	-	-	-	1	1	4	5	1	-	10	11
barred surfperch	1	1	3	2	7	2	-	-	-	2	9
thornback	1	1	-	1	3	-	3	-	-	3	6
bat ray	2	2	-	-	4	-	1	-	-	1	5
spotted turbot	-	-	-	-	-	-	-	2	1	3	3
yellowfin croaker	-	3	-	-	3	-	-	-	-	-	3
hornyhead turbot	-	-	-	-	-	-	-	1	1	2	2
Pacific butterflyfish	-	-	-	-	-	1	1	-	-	2	2
California halibut	-	-	-	1	1	-	-	-	-	-	1
fantail sole	-	-	-	-	-	-	-	-	1	1	1
Pacific angel shark	-	-	-	-	-	-	1	-	-	1	1
Pacific sardine	-	-	-	-	-	-	1	-	-	1	1
plainfin midshipman	-	-	-	-	-	-	-	1	-	1	1
spiny dogfish	-	-	-	-	-	-	-	1	-	1	1
tube-snout	-	-	-	-	-	1	-	-	-	1	1
white seaperch	-	-	-	-	-	-	-	-	1	1	1
Abundance	1075	526	42	292	1935	393	810	2811	375	4389	6324
Number of species	9	10	7	11	13	10	12	13	11	22	24
Diversity (H')	1.47	1.84	1.78	1.78	1.17	1.74	0.79	0.47	0.54	0.58	

0.0 = <0.01

**Abundance.** A total of 6,324 fish were taken in the winter and summer trawl surveys (Table 10). Queenfish was the most abundant species overall, comprising over 73% of the total catch, followed by white croaker (16%), northern anchovy (6%), and kelp pipefish (2%). Together these four species accounted for 97.2% of the total catch.

The winter catch totaled 1,935 individuals and averaged 484 individuals per station (Appendix H-2). Abundance ranged from 42 individuals at Station T3 to 1,075 individuals (56% of the total winter trawl catch) at Station T1 (Table 10). The summer catch totaled 4,389 individuals and averaged 1,097 individuals per station (Appendix H-3). Abundance ranged from 375 individuals at Station T4 to 2,811 individuals (64% of the total summer trawl catch) at Station T3. At Station T3, the summer catch was nearly 67 times the winter catch due to the high abundance of queenfish in one replicate.

**Species Richness.** Thirteen species were taken in winter and 22 in summer, with 11 species common to both surveys (Table 10). In winter, the number of species collected ranged from seven species at Station T3 to 11 species at Station T4, with an average of nine species per station. In summer, species richness ranged from 10 species at Station T1 to 13 species at Station T3, with an average of 12 species per station.

**Diversity (H').** Overall Shannon-Wiener species diversity was 1.17 in winter and 0.58 in summer (Table 10). In winter, species diversity ranged from 1.47 at Station T1 to 1.84 at Station T2. In summer, species diversity ranged from 0.47 at Station T3 to 1.74 at Station T1. In summer,

lower diversity values at Stations T2 through T4 resulted from higher abundance of queenfish relative to other species. At those three stations, queenfish comprised 86% to 97% of total station abundance.

**Biomass.** The total combined weight of fish taken during the winter and summer trawl surveys was 86.7 kg, with 75% (64.7 kg) taken in summer (Table 11). Biomass averaged 5.5 kg per station in winter and 16.2 kg per station during summer (Appendices H-4 and H-5). Biomass was lowest in winter at Station T3, where abundance was lowest, while highest biomass in winter occurred at Station T1, where abundance was highest. In summer, biomass was lowest at Station T1, where abundance was second lowest, while highest biomass occurred at Station T3, where abundance was highest.

**Table 11. Biomass (kg) of fish species taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Winter					Summer					Grand	
	T1	T2	T3	T4	Total	T1	T2	T3	T4	Total	Total	Percent
queenfish	2.122	0.603	0.026	0.247	2.998	0.955	8.534	30.398	3.469	43.356	46.354	53.454
bat ray	11.450	0.935	-	-	12.385	-	0.877	-	-	0.877	13.262	15.293
Pacific angel shark	-	-	-	-	-	-	11.300	-	-	11.300	11.300	13.031
white croaker	0.839	0.738	0.012	0.505	2.094	0.339	0.319	0.426	0.042	1.126	3.220	3.713
California corbina	0.354	0.960	-	1.598	2.912	-	-	0.232	-	0.232	3.144	3.626
spiny dogfish	-	-	-	-	-	-	-	3.050	-	3.050	3.050	3.517
northern anchovy	0.257	0.095	0.092	0.018	0.462	1.667	0.304	0.125	0.097	2.193	2.655	3.062
thornback	0.015	0.010	-	0.019	0.044	-	1.204	-	-	1.204	1.248	1.439
California halibut	-	-	-	0.570	0.570	-	-	-	-	-	0.570	0.657
California lizardfish	-	-	0.007	0.015	0.022	0.052	0.046	0.302	0.034	0.434	0.456	0.526
barred surfperch	0.033	0.058	0.125	0.039	0.255	0.034	-	-	-	0.034	0.289	0.333
walleye surfperch	-	-	-	-	-	0.014	0.018	0.144	0.072	0.248	0.248	0.286
kelp pipefish	0.031	0.009	0.003	0.009	0.052	0.089	0.047	0.024	0.002	0.162	0.214	0.247
speckled sanddab	0.034	0.060	0.011	0.051	0.156	-	-	0.008	0.013	0.021	0.177	0.204
fantail sole	-	-	-	-	-	-	-	-	0.157	0.157	0.157	0.181
shiner perch	-	-	-	0.017	0.017	0.052	0.043	0.026	-	0.121	0.138	0.159
hornyhead turbot	-	-	-	-	-	-	-	0.024	0.066	0.090	0.090	0.104
Pacific sardine	-	-	-	-	-	-	0.053	-	-	0.053	0.053	0.061
Pacific butterfish	-	-	-	-	-	0.018	0.016	-	-	0.034	0.034	0.039
plainfin midshipman	-	-	-	-	-	-	-	0.022	-	0.022	0.022	0.025
yellowfin croaker	-	0.020	-	-	0.020	-	-	-	-	-	0.020	0.023
spotted turbot	-	-	-	-	-	-	-	0.006	0.003	0.009	0.009	0.010
white seaperch	-	-	-	-	-	-	-	-	0.005	0.005	0.005	0.006
tube-snout	-	-	-	-	-	0.003	-	-	-	0.003	0.003	0.003
<b>Total Biomass (kg)</b>	<b>15.14</b>	<b>3.488</b>	<b>0.276</b>	<b>3.088</b>	<b>21.987</b>	<b>3.223</b>	<b>22.761</b>	<b>34.787</b>	<b>3.960</b>	<b>64.731</b>	<b>86.718</b>	

Queenfish accounted for 53% of total biomass due to the large number of individuals taken during both surveys (Table 10). Bat ray accounted for 15% of total biomass, though only five individuals were collected (four in winter and one in summer). One individual Pacific angel shark (*Squatina californica*) collected in summer accounted for over 13% of total biomass. White croaker, California corbina, spiny dogfish (*Squalus acanthias*), northern anchovy, and thornback each contributed 1% or more to the total biomass. Together, these eight species comprised more than 97% of the total biomass. The remaining 16 species each contributed less than 4% to the total biomass, together accounting for slightly less than 3% of the total biomass.

**Size (Length).** Lengths of all measured fish ranged from 22 mm standard length (SL) to 1,005 mm total length (TL) during both surveys (Table 12). In winter the smallest measured individual was a speckled sanddab at 22 mm SL, and the largest individual was a bat ray with a disc width of 777 mm. Disc width is measured on bat rays since they are occasionally captured with missing tails. Bat ray, California halibut (*Paralichthys californicus*), and California corbina had the greatest mean lengths in winter. In summer the smallest measured individual was a speckled sanddab at 25 mm SL, and the largest individuals were a Pacific angel shark measuring 1,005 mm

TL and a spiny dogfish measuring 880 mm TL. Aside from these two large fish, bat ray, thornback, and California corbina had the greatest mean lengths in summer.

**Table 12. Standard length (mm) of fish species taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Winter					Summer			
	Number	Min	Max	Mean	SD	Number	Min	Max	Mean
queenfish	532	40	138	62.1	10.3	899	52	160	89.8
northern anchovy	145	36	105	71.0	12.2	238	45	128	97.2
white croaker	786	30	146	47.7	12.1	127	32	145	74.6
kelp pipefish	26	130	272	196.9	36.0	79	159	246	204.4
walleye surfperch	-	-	-	-	-	37	53	75	67.0
California lizardfish	5	86	98	90.8	4.8	21	123	175	145.0
shiner perch	1	116	116	116.0	-	10	36	105	75.5
speckled sanddab	31	22	116	71.0	19.9	8	25	77	47.3
spotted turbot	-	-	-	-	-	3	52	62	56.3
thornback*	3	142	162	151.3	10.1	3	381	400	390.3
barred surfperch	7	92	124	109.1	10.0	2	83	88	85.5
hornyhead turbot	-	-	-	-	-	2	114	140	127.0
Pacific butterflyfish	-	-	-	-	-	2	77	106	91.5
bat ray**	4	297	777	470.8	214.7	1	392	392	392.0
California corbina	23	134	250	198.1	35.7	1	264	264	264.0
fantail sole	-	-	-	-	-	1	190	190	190.0
Pacific angel shark	-	-	-	-	-	1	1005	1005	1005.0
Pacific sardine	-	-	-	-	-	1	166	166	166.0
plainfin midshipman	-	-	-	-	-	1	148	148	148.0
spiny dogfish	-	-	-	-	-	1	880	880	880.0
tube-snout	-	-	-	-	-	1	98	98	98.0
white seaperch	-	-	-	-	-	1	55	55	55.0
California halibut	1	329	329	329.0	-	-	-	-	-
yellowfin croaker	3	68	81	75.0	6.6	-	-	-	-

\* = total length measured, \*\* = disc width measured.

SD = standard deviation

The smallest fish taken during both surveys were juveniles or transforming larvae of white croaker, queenfish, and speckled sanddab. White croaker, queenfish and northern anchovy less than 30 mm SL are not included in analyses because these larval fish are not adequately sampled by otter trawl. The presence of queenfish and white croaker less than 30 mm SL was noted as it indicates recent recruitment (Appendices H-6 and H-7).

**Population Structure.** Length-frequency histograms of the three most abundant species, northern anchovy, queenfish, and white croaker, are presented in Figures 14 through 16. These species were caught in sufficient numbers to make general seasonal comparisons. The average lengths of these three species were almost 30 mm greater in summer than in winter, reflecting the greater number of smaller individuals captured in winter.

Trawl-caught northern anchovy ranged in length from 36 to 105 mm SL in winter (Table 12), with a single mode at 60 mm SL (Figure 14). In summer, northern anchovy ranged in length from 45 to 128 mm SL, with most individuals between 90 and 110 mm SL.

In winter, 532 measured queenfish ranged in size from 40 to 138 mm SL, and averaged 62 mm SL (Table 12). The length-frequency distribution shows most fish were 50 to 70 mm SL (Figure 15). In summer, the 899 measured queenfish ranged in size from 52 to 160 mm SL, with an average length of 90 mm SL. The summer queenfish length-frequency distribution peaked at 80 mm SL.

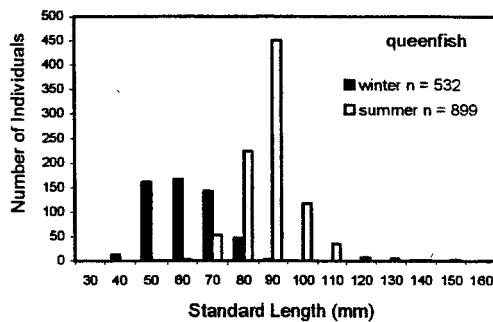


Figure 14. Length-frequency distribution of queenfish (*Seriphus politus*) taken by otter trawl. Reliant Energy Mandalay generating station NPDES, summer 2001.

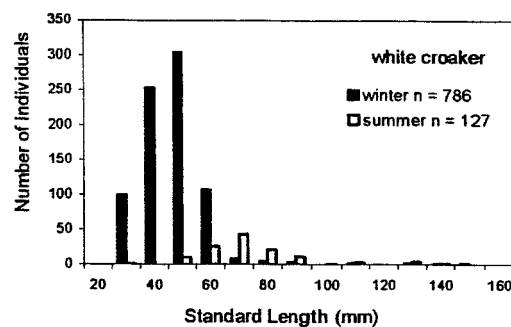


Figure 15. Length-frequency distribution of white croaker (*Genyonemus lineatus*) taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.

The white croaker population was unimodal in winter and summer (Figure 16). In winter, there was a peak at 50 mm SL, and measured fish ranged from 30 to 146 mm SL (Table 12). In summer, measured fish ranged from 32 to 145 mm SL and distribution peaked at 70 mm.

**Cluster Analyses.** Normal (station) and inverse (species) cluster analyses were performed on the trawl data for fish species collected during both winter and summer surveys (Figures 17 and 18).

In winter, the four stations fell into a single group based on the relative abundances of fish species (Figure 17). Station T3 was slightly dissimilar from the other three stations, with relatively few species and individuals taken there. Fish species divided into two groups based on their similarity of occurrence. Species Group A contained the three most abundant species at all four stations (white croaker, queenfish, and northern anchovy). Species Group B included all other species.

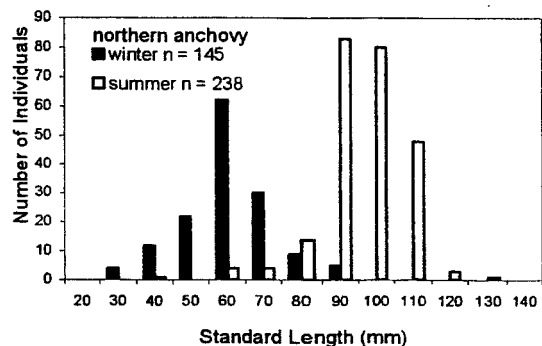


Figure 16. Length-frequency distribution of northern anchovy (*Engraulis mordax*) taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.

In summer, the four stations fell into a single group based on the relative abundances of fish species (Figure 18). Upcoast Stations T1 and T2 were slightly dissimilar to downcoast Stations T3 and T4. Fish species divided into three groups based on their similarity of occurrence. Species Group A was composed of a single species, queenfish, that was very dominant at three of the trawl stations. Species Group B included the second, third, and fourth most abundant species that occurred in moderate to low numbers at all four stations. Species Group C contained all other species.

**Diseases and Abnormalities.** In 2001, no fish with signs of disease, lesions, or papillomas were collected in the study area. In winter, one northern anchovy, one white croaker, and three queenfish were externally parasitized by fish lice of the genera *Lironeca* and *Nerocila* (Appendix H-6). In summer, five queenfish were externally parasitized by *Lironeca* (Appendix H-7).

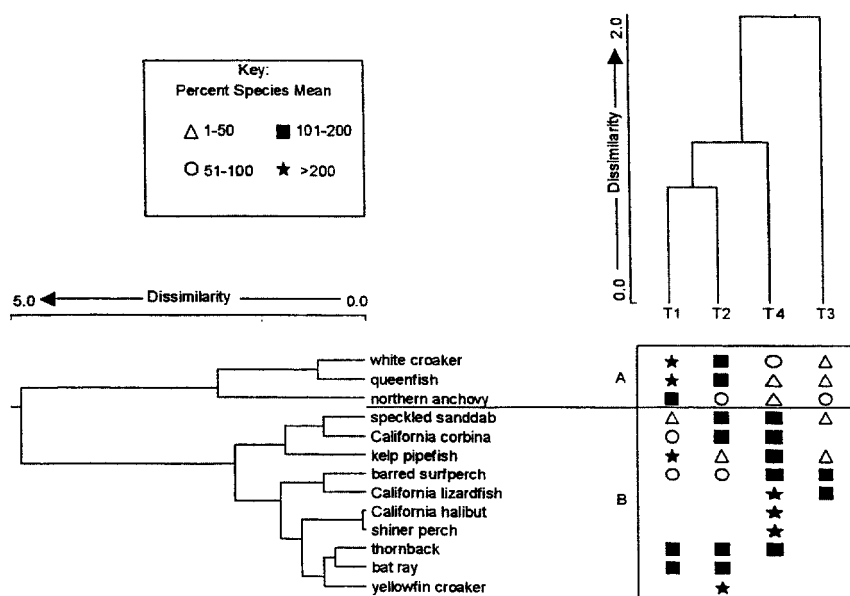


Figure 17. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for fish taken by otter trawl, winter survey. Reliant Energy Mandalay generating station NPDES, 2001.

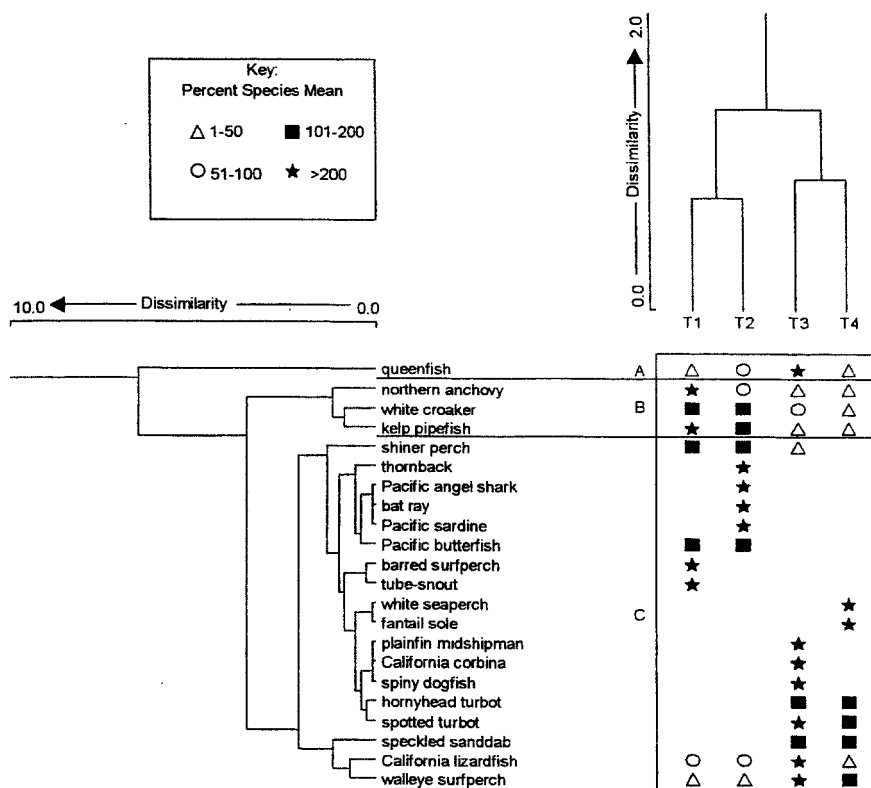


Figure 18. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for fish taken by otter trawl, summer survey. Reliant Energy Mandalay generating station NPDES, 2001.

### Macroinvertebrates

**Species Composition.** Individuals of 12 macroinvertebrate species (excluding fish lice) were collected during the winter and summer demersal fish surveys (Table 13, Appendices H-1, H-8 and H-9). The 12 species represented four phyla and 11 families, and included seven species of arthropods, two species each of echinoderms and mollusks, and one cnidarian. Pacific sand dollar (*Dendraster excentricus*), blackspotted bay shrimp (*Crangon nigromaculata*), and graceful rock crab (*Cancer gracilis*) were the only species taken at all four stations during both winter and summer surveys. All other species in winter and summer were collected at only one or two stations. Aside from the three previously mentioned species, tuberculate pear crab (*Pyromaia tuberculata*) was the only other species collected in both winter and summer.

**Table 13. Abundance and catch parameters for macroinvertebrates species taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Winter					Summer					Total	Percent
	T1	T2	T3	T4	Total	T1	T2	T3	T4	Total		
Pacific sand dollar	956	906	976	1044	3882	296	528	2938	4117	7879	11761	93.25
blackspotted bay shrimp	174	276	6	26	482	36	123	67	24	250	732	5.80
graceful rock crab	23	3	18	34	78	7	2	2	14	25	103	0.82
California spiny lobster	-	1	-	2	3	-	-	-	-	-	3	0.02
intertidal coastal shrimp	-	-	-	-	-	-	1	2	-	3	3	0.02
tuberculate pear crab	1	-	-	-	1	1	1	-	-	2	3	0.02
topsnail	-	-	-	-	-	-	-	-	2	2	2	0.02
sea pansy	-	-	-	-	-	-	-	-	1	1	1	0.01
sweet potato	-	1	-	-	1	-	-	-	-	-	1	0.01
Xantus swimming crab	-	1	-	-	1	-	-	-	-	-	1	0.01
fat western nassa	-	-	-	-	-	-	-	1	-	1	1	0.01
yellow crab	-	-	-	-	-	-	1	-	-	1	1	0.01
Abundance	1154	1188	1000	1106	4448	340	656	3010	4158	8164	12612	
Number of species	4	6	3	4	7	4	6	5	5	9	12	
Diversity (H')	1.19	1.21	0.81	0.94	0.44	1.02	0.86	0.81	0.64	0.17		
Biomass (kg)	4.42	4.33	4.06	5.24	18.05	1.47	3.34	17.31	22.90	45.01	63.05	

**Abundance.** A total of 12,612 individuals were taken during the winter and summer surveys (Table 13, Appendices H-8 and H-9). In winter, the catch totaled 4,448 individuals, about 35% of macroinvertebrate abundance for the year. Abundance was similar among stations, ranging from 1,000 individuals at Station T3 to 1,188 individuals at Station T2. The summer catch totaled 8,164 individuals, comprising 65% of total annual abundance. Abundance per station was more variable than in winter, ranging from 340 individuals at Station T1 to 4,158 individuals at Station T4. Sixty-five percent of the total summer trawl catch was collected at Station T4.

The most common macroinvertebrate was Pacific sand dollar with 11,761 individuals, accounting for 87% of winter abundance and 97% of summer abundance, and 93% of all individuals taken during both surveys (Table 13). Blackspotted bay shrimp comprised almost 11% of winter abundance and 3% of summer abundance. Graceful rock crab accounted for almost 2% of winter abundance and less than 1% of summer abundance. In winter, the remaining four species were represented by six individuals. In summer, the remaining six species were represented by 16 individuals.

**Species Richness.** Twelve macroinvertebrate species (excluding fish lice) were collected during the 2001 trawl surveys; seven in winter and nine in summer (Table 13, Appendices H-1, H-8, and H-9). In winter, the number of species collected ranged from three species at Station T3 to six species at Station T2. Species richness in summer ranged from four species at Station T1 to six species at Station T2.

**Diversity (H').** Overall Shannon-Wiener species diversity was slightly higher in winter than in summer (Table 13). Diversity ranged from 0.81 to 1.21 in winter and from 0.64 to 1.02 in summer. Overall diversity was 0.44 in winter and 0.17 in summer.

**Biomass.** Macroinvertebrate biomass was 18.1 kg in winter and 45.0 kg in summer (Table 13 Appendices H-10 and H-11). In winter, biomass ranged from 4.1 kg at Station T3 to 5.2 kg at Station T4. In summer, biomass ranged from 1.5 kg at Station T1 to 22.9 kg at Station T4. Pacific sand dollar contributed most to total biomass during both surveys; 86% in winter and almost 99% in summer. Blackspotted bay shrimp contributed 6% to biomass in winter and 1% in summer.

## Impingement

Fish impingement monitoring was initiated at Mandalay generating station beginning in June 2001 and continued through September 2001 for this report. Results are presented in their entirety in Appendix I. A master list of fish and invertebrate species impinged is presented in Appendix I-1. Tables summarizing fish and macroinvertebrate data are presented in the following text.

### Fish

In 2001, fish were examined during one heat treatment survey and two normal operation surveys at Mandalay generating station.

**Species Composition.** The combined surveys yielded six species of fish, representing two classes and six families (Appendix I-1). The one family of cartilaginous fish (Elasmobranchiomorphi = Chondrichthyes) and five families of bony fish (Osteichthyes) were represented by one species in each family.

**Abundance.** The one heat treatment and two normal operation surveys yielded an estimated total impingement of 186 individual fish (Table 14, Appendices I-2 and I-4). Almost 98% of the individuals were estimated to occur during normal operations, with 3% (6 individuals) taken during the heat treatment.

**Table 14. Number of individuals and biomass (kg) of fish species impinged during heat treatment and normal operation surveys. Reliant Energy Mandalay generating station NPDES, 2001.**

Common Name	Abundance	Biomass	Percent		Cumulative Percent	
			Abundance	Biomass	Abundance	Biomass
Pacific staghorn sculpin	81	2.417	43.5	25.2	43.5	25.2
shiner perch	27	0.612	14.5	6.4	58.1	31.6
California halibut	27	0.269	14.5	2.8	72.6	34.4
pipefish	24	0.049	12.9	0.5	85.5	34.9
round stingray	24	6.114	12.9	63.8	98.4	98.7
northern anchovy	3	0.120	1.6	1.3	100.0	100.0
Survey Totals	186	9.581				
Total Species	6					

The most abundant species at Mandalay generating station was Pacific staghorn sculpin (*Leptocottus armatus*) which accounted for an estimated 43.5% (81 individuals) of all of the individuals taken in 2001 (Table 14). Shiner perch and California halibut, were tied for second place accounting for 14.5% of the individuals, while pipefish (*Syngnathus* spp.) and round stingray (*Urolophus halleri*), each accounting for 12.9%, were tied for fourth place. The remaining species, northern anchovy, accounted for less than 2% of the total abundance.

**Biomass.** Fish biomass from the heat treatment and normal operation surveys totaled an estimated 9.58 kg of fish (Table 14, Appendices I-2 and I-4). Biomass was similarly divided as abundance between the normal operation surveys (97.7%, 9.36 kg) and the heat treatment (3.3%, 0.22 kg) surveys.

The top three species, round stingray, Pacific staghorn sculpin, and shiner perch, accounted for slightly over 95% of the total biomass (Table 14). Two of these three species were also among the three most abundant species. The remaining three species contributed approximately 5% of the overall biomass.

**Size (Length).** Standard lengths (mm SL) for each individual per species were recorded during impingement surveys. Insufficient numbers of fish were measured to construct length frequency histograms.

**Diseases and Abnormalities.** No diseases or abnormalities were noted on any fish measured during the impingement surveys.

### Macroinvertebrates

In total, five macroinvertebrate species representing two phyla and five families (Appendix I-1), with a total estimated abundance of 154 individuals and an estimated biomass of 4.90 kg, were impinged during the normal operation and heat treatment surveys (Table 15 and Appendices I-5 and I-6). Mollusks were represented by three species and arthropods (all crustaceans) by two species.

Table 15. Number of individuals and biomass (kg) of macroinvertebrate species impinged during heat treatment and normal operation surveys. Reliant Energy Mandalay generating station NPDES, 2001.

Common Name	Abundance	Biomass	Percent		Cumulative Percent	
			Abundance	Biomass	Abundance	Biomass
California market squid	124	3.397	80.52	69.28	80.5	69.3
striped shore crab	27	0.806	17.53	16.44	98.1	85.7
sea hare	1	0.400	0.65	8.16	98.7	93.9
Pacific rock crab	1	0.100	0.65	2.04	99.4	95.9
California two-spot octopus	1	0.200	0.65	4.08	100.0	100.0
Survey Totals	154	4.903				
Total Species	5					

California market squid (*Loligo opalescens*) comprised 80.5% of total invertebrate abundance, and 69.3% of total biomass (Table 15). Striped shore crab (*Pachygrapsus crassipes*) also contributed 17.5% to the abundance and 16.4% to the biomass. These two species accounted for 98% of total invertebrate abundance and, together with sea hare (*Aplysia californica*), comprised almost 94% of total invertebrate biomass.

## DISCUSSION

### WATER COLUMN MONITORING

#### Temperature

Data collected for the 2001 NPDES winter and summer surveys indicated there was a slight thermal effluent during both surveys at the surf-zone and some offshore stations in the vicinity of the discharge channel. This pattern appears to be common in the area and has been noted in past surveys (MBC 1990, 1994-1999a, 2000a; Ogden 1991-1993). On the day winter sampling was

conducted, the generating station was discharging water that was approximately 14°C above the mean offshore water temperature. (Plant operations increased the temperature of the intake water by approximately 11°C, while the intake water, which is drawn from the back of Channel Islands Harbor through the Edison Canal, was about 3°C warmer than the mean offshore surface temperature.) During both tides, a thermal plume was apparent at Station RW5, at the discharge channel, as well as at other stations in the area. During the morning ebb tide, temperature at the discharge channel was approximately 10°C above the mean offshore surface temperature. Temperatures at the two surf-zone stations upcoast of the discharge were elevated, about 5°C above ambient at the nearest station and about 2.5°C above ambient at the furthest station, with temperatures near normal at the downcoast stations. Surface water temperature was elevated at offshore upcoast Station RW16 during flood tide. No temperature increases were indicated at other offshore stations. This suggests that during flood tide sampling, discharge water spread in the surf-zone and upcoast of the discharge channel moving principally as a warm-water surface lens. During the afternoon flood tide, surface water temperatures were slightly cooler at the offshore stations than during the ebb tide sampling and temperature at the discharge channel was only about 4°C above the mean offshore surface temperature. Upcoast surf-zone station temperatures were elevated 2 to 4°C or more above offshore ambient temperatures, decreasing with distance upcoast from the discharge channel, while downcoast surf-zone station temperatures were again near normal. No temperature elevations were noted at any of the offshore stations.

During summer sampling, water being discharged from the channel was approximately 14.5°C above ambient offshore temperatures. During the morning flood tide sampling, a nearshore thermal plume extended from the discharge channel upcoast in the surf-zone as far as Station RW3, but was not detected at any offshore stations on either tide. Temperatures at the downcoast surf-zone stations did not indicate any thermal elevation. During the midday ebb tide sampling, elevated water temperatures were again found at the surf-zone stations at and upcoast of the discharge channel, as far as Station RW3. Flood tide currents in the vicinity of the generating station typically flow upcoast, while ebb tide currents flow downcoast (IRC 1973). These currents appear as a progressive tide wave with strongest upcoast currents occurring near the time of high water and peak downcoast currents occurring near the time of low water. In winter, a thermal plume was detected upcoast at surf-zone stations and at one offshore station, with highest temperatures found at and upcoast of the discharge on ebb tide. The same pattern was found, to a lesser degree, during flood tide, which is atypical. During both tides in summer, a thermal plume was detected primarily upcoast at surf-zone and some offshore stations, with minor tidal differences. Water quality sampling in 2001 occurred shortly before and following tide change during both winter and summer. This might account for similar patterns of distribution during both tides (due to lag time following tidal change), except that during both seasons the distribution differed from expected during the first tide sampled. In 2001, the distribution of a thermal field around the discharge appeared to be a result of seasonal variation of local currents with a reduced tidal influence.

Thermal influence from the discharge was minor at the offshore stations. Most stations were unaffected by the thermal field, and even at those offshore stations noted previously, surface temperature elevations were slightly more than 2°C above the mean. Temperature profiles at offshore stations were typical for areas along the open coastline, with thermoclines between 1 and 4 m below the surface. Development of thermoclines is common during summer in southern California waters as the surface is heated by solar absorption. Warmer temperatures recorded during afternoon tides is also common, again the result of solar warming. In 1999, cooler water temperatures noted in the Southern California Bight were strongly influenced by a lingering La Niña, a rebound effect from the 1997-98 El Niño - Southern Oscillation event that diverted warmer waters from the equatorial Pacific northward (NOAA 1999). Surface and bottom temperatures at offshore stations in 1999 were considerably cooler than temperatures recorded in the 1998 or the 1997 summer surveys (MBC 1997-1999a). In 2001, temperatures at all offshore stations were again within ranges common in previous surveys at the generating station (MBC 1990, 1994-1999a, 2000a; Ogden 1991-1993).

## Dissolved Oxygen

The concentration of DO in seawater is affected by several physical, chemical, and biological variables. High DO concentrations may result from cool water temperatures (solubility of oxygen in water increases as temperature decreases), active photosynthesis, and/or mixing at the air-water interface (Sverdrup et al. 1942). Conversely, low concentrations may result from high water temperatures, high rates of organic decomposition, and/or extensive mixing of surface waters with oxygen-poor subsurface waters.

In 2001, DO concentrations in winter at offshore stations were high and similar among stations and between tides. During summer, DO profiles fluctuated more widely with ranges exceeding 4 mg/l between tides; the fluctuation was very similar to that noted with the temperature pattern. However, the pattern was atypical as DO increased as the temperature increased. It is probable that in this circumstance that solar insolation increased primary productivity in the afternoon which in turn increased the production of DO. This is consistent with the observation of very strong plankton blooms (red tides) in most of the study area during the sampling period. Dissolved oxygen samples were unusually low during the morning flood tide sampling, a finding again consistent with the red tide observations which typically results in a DO deficit in the waters until solar illumination re-energizes the phytoplankton. At each station, the maximum DO values corresponded to the deepest end of the thermocline, below which DO decreased with depth. Dissolved oxygen concentrations at offshore stations showed no patterns relative to the discharge.

In winter, DO values were generally similar at the surf-zone stations to the offshore stations. Dissolved oxygen concentrations showed no pattern relative to the discharge. During summer, DO concentrations at the surf-zone stations were typical and high, while they varied greatly offshore due to the plankton bloom. Dissolved oxygen concentrations inversely corresponded to water temperature, with the lowest DO values found at the discharge station, where temperatures were highest. Dissolved oxygen concentrations at surf-zone stations were above levels considered adequate to protect the beneficial uses of the receiving waters.

## Hydrogen Ion Concentration

In the open ocean, hydrogen ion concentration (pH) remains fairly constant due to the buffering capacity of seawater (Sverdrup et al. 1942). However, in nearshore areas, pH may be more variable due to physical, chemical, and biological influences. For instance, in areas with a large organic influx, such as bays, estuaries, and river mouths, microbial decomposition is greater than offshore. Along with a reduction in DO, decomposition also results in the production of humic acids, which decrease pH (Duxbury and Duxbury 1984). Reduced pH values may also occur in areas of freshwater influx, since freshwater usually has a lower pH than saltwater. In contrast, phytoplankton blooms, which are often associated with nearshore upwelling, may increase pH. High photosynthetic rates increase the removal of carbon dioxide from water, thus reducing the carbonic acid concentration and raising pH.

In 2001, pH concentrations at all surf-zone and offshore receiving water monitoring stations were similar to values typically found in the open ocean. Surf-zone and offshore pH values were similar among stations and between tides, although the pH values recorded in the discharge channel were slightly lower than at other surf-zone stations. At offshore stations, hydrogen ion concentrations varied little from surface to bottom. In summer, a similar pattern, as would be expected, was noted with pH as was seen with temperature and DO. All pH concentrations were well within the level of variation seen in the study area and the Southern California Bight; no concentrations were at a level that would adversely affect marine life (MBC 1990, 1994-1999a, 2000a), Ogden 1991-1993). It appeared that the discharge had little or no discernable effect upon the pH concentrations in the study area.

## Salinity

Salinity in the open ocean is generally 35 parts per thousand (ppt); that is, a 1,000-g sample of ocean water contains 35 g of dissolved compounds, collectively referred to as salts (Sverdrup et al. 1942). In nearshore areas subjected to freshwater influx, however, salinity is usually slightly lower. In southern California, salinity of nearshore waters is generally between 33 and 34 ppt (Dailey et al. 1993). Reductions in nearshore salinity usually result from freshwater input, while slight increases are often associated with upwelling of colder, more saline bottom waters.

In winter, salinity concentrations in the upper 2 to 4 m were somewhat diluted as levels were 1 to 1.5 ppt lower than normal. This was probably the result of recent rains and runoff. In summer, salinity was uniform throughout the water column with slight excursions that are probably related to differing water masses.

## SEDIMENT MONITORING

### Sediment Grain Size

In 2001, sediments were coarsest at Station B1, off the Mandalay generating station discharge canal, and finest at Station B5, nearly one nautical mile upcoast from the generating station. The amount of "fines" (silt and clay combined) in sediments ranged from 3.1 to 5.2% at Stations B1 through B4, but was 14.8% at Station B5. The largest percentage of fines has been recorded at Station B5 in eight of the last nine surveys (excluding 1998 when only three stations were sampled) (Figure 19 and Appendix D). Station B5 is located less than one nautical mile downcoast from the mouth of the Santa Clara River, which discharges an estimated 3.7 million tons of sediment per year (Dailey et al. 1993). While sands in the east Santa Barbara Channel are locally derived, the majority of the fine load originates from the Santa Ynez, Ventura, and Santa Clara rivers (Kolpack 1971). The normally southeasterly movement of sediment from the Ventura River area is interrupted by the trap effect of the Ventura Marina breakwater and jetties. Long-term monitoring off Mandalay suggests more of the fine material carried down the Santa Clara River is deposited at Station B5 than at the other four stations in the study area.

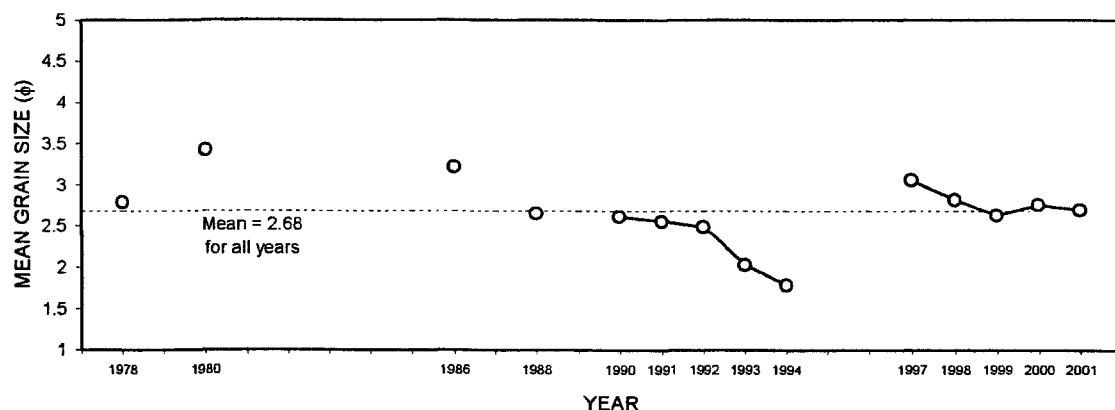


Figure 19. Comparison of sediment mean grain size. Reliant Energy Mandalay generating station NPDES, 2001.

Sediments have been coarsest off the discharge canal in only four of nine surveys since 1990 (excluding 1998), and were coarsest there in 2000 and 2001. While the Mandalay generating station discharge can produce a noticeable effect on currents up to 2,000 ft offshore (IRC 1973), it is unlikely that the discharge itself creates enough turbulence to affect sediment distribution on the

20-ft isobath. It is unknown, however, to what degree altered nearshore current patterns could affect sediment parameters on the 20-ft isobath. Average sediment grain size in the study area has remained consistent, with most yearly averages in the fine to very fine sand range. Coarsest sediments in the last 23 years occurred off the generating station in 1994 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999a, 2000a; Ogden 1991-1993). Sediment characteristics off the generating station are likely primarily affected by natural causes, such as sediment transport, heavy rains, deposition from the Santa Clara River, increased wave action from storms, and nearshore currents. Results from the 2001 survey show no apparent patterns in sediment grain size relative to the Mandalay generating station discharge canal.

### Sediment Chemistry

Sediments at five stations off the Mandalay generating station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Highest concentrations of all metals were found at Station B4, nearly one nautical mile downcoast of the discharge canal. Lowest concentrations of all metals occurred at Stations B2 (2,360 ft downcoast of the discharge) and B5 (nearly one nautical mile upcoast of the discharge).

Differences in metal concentrations among sites are often directly related to the amount of fine-grained material in the sediment. Fine-grained sediments may contain higher amounts of metals due to the greater available surface area (Ackermann 1980, de Groot et al. 1982). Comparisons should take into account the relative amounts of fine and coarse sediments. Sediments in the study area have consistently been sandy. In the last three years, the largest percentages of fines (silt and clay combined) have been recorded at Station B5 (Figure 20). In 1999 and 2000, highest concentrations of most metals occurred in sediments at that station. In 2001, even though sediments were finest at Station B5, highest sediment metal concentrations occurred at Station B4, which had the lowest percentage of fine material. Reasons for the slightly higher metal concentrations at Station B4 are unknown. All sediment metal concentrations in 2001 were similar (standard deviations were less than 2.1), and there was no pattern of metals distribution relative to the generating station discharge.

All values observed in 2001 were within the ranges found in sediments within the Southern California Bight and were lower than or comparable to levels found by the National Oceanographic and Atmospheric Administration (NOAA) at other sandy, offshore sites in southern California (NOAA 1991a). Concentrations of metals in the study area have consistently been below levels determined to be potentially toxic to benthic organisms. Ranges of potential toxicity were developed by NOAA (NOAA 1991b) and later updated (Long et al. 1995), using data from spiked sediment bioassays, sediment-water equilibrium partitioning, and the co-occurrence of adversely affected fauna and contaminant levels in the field. Chemical concentrations believed to be associated with adverse biological effects from the various independent studies were compared for each parameter and the lower 10 percentile was designated as the "Effects Range-Low" (ERL). Except during the 1991 survey, metal concentrations in the study area were generally near one-half or less of the determined concentration for low effects. Percentages of fines in sediments decreased at all stations since last year. Concentrations of most metals also declined between 2000 and 2001, exceptions being increases of chromium, nickel, and zinc at Station B4, and an increase in chromium at Station B3.

Pollutants come from a variety of sources of both industrial and domestic origin. Oil and gasoline combustion releases many substances, including cadmium, copper, chromium, lead, mercury, and zinc. These and other metals are used in paints, pigments, batteries, manufacturing, and protective coatings. Aerial fallout is a diffuse and potentially large source of contaminants derived from other sources, and may include metals, chlorinated hydrocarbons, and PAHs (SCCWRP 1973, 1986). As these contaminants accumulate on the ground, they are washed into rivers by rainfall, and are eventually deposited in the ocean.

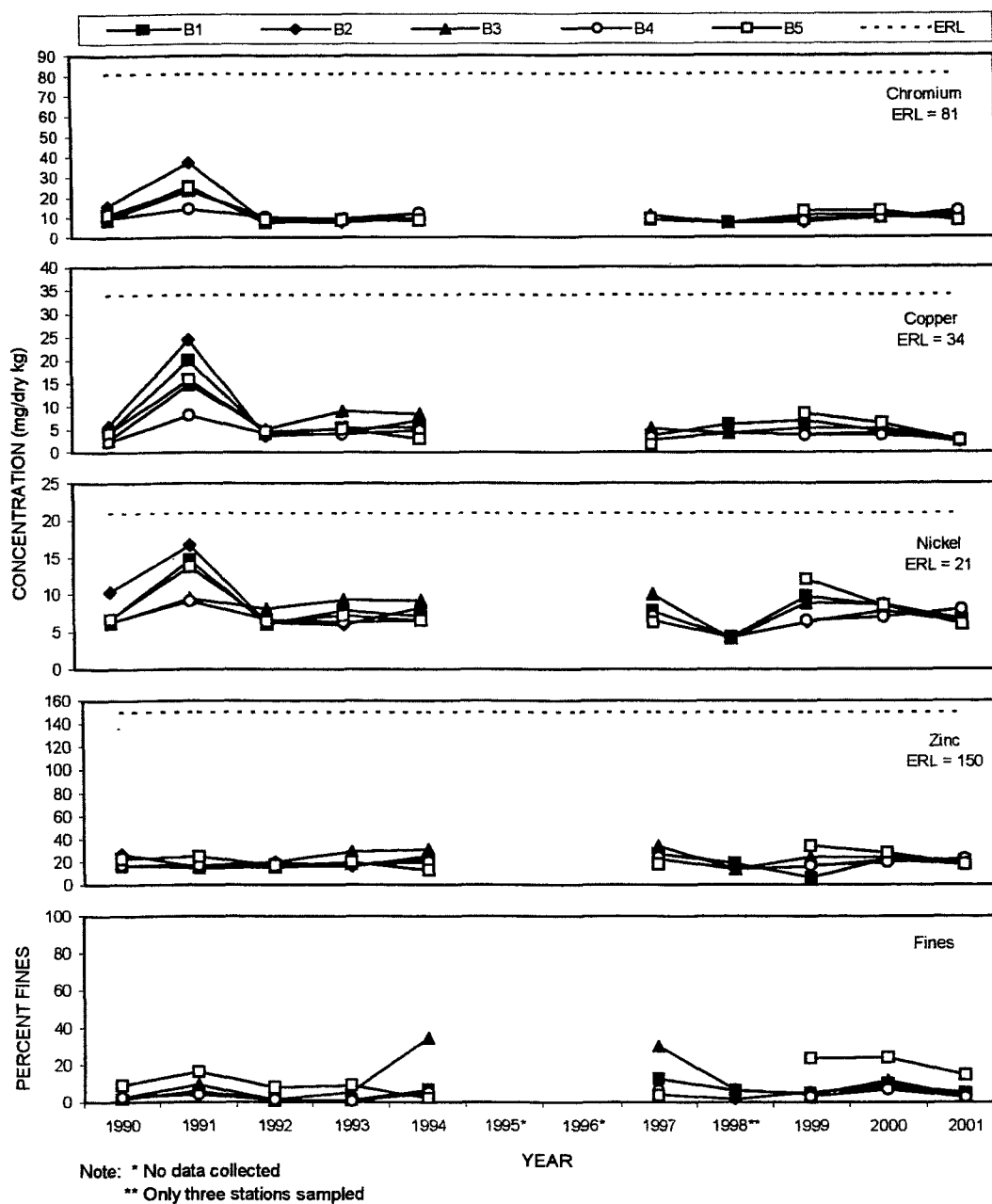


Figure 20. Comparison of sediment metal concentrations and percent fines by station, 1990 - 2001. Reliant Energy Mandalay generating station NPDES, 2001.

Metal levels have remained relatively constant in the area since 1990, with the exception of the 1991 survey. The distribution of metals in the study area has historically been linked to localized changes in sediment grain size; however, in 2001, this was not the case. Reasons for the relatively higher levels of sediment metals at Station B4 are unknown. However, there was no pattern of metals distribution relative to the generating station discharge in 2001.

## MUSSEL BIOACCUMULATION

In 2001, bay mussels were outplanted offshore of the discharge at the Mandalay generating station study area and allowed to bioaccumulate for a period of about 90 days for analysis of selected metals in the mussel tissues. Effects range low (ERL) levels were derived for sediments and are used here for comparison; however, they may not be appropriate for mussel metal levels.

Bay mussel tissue collected offshore of the discharge structure in 2001 had detectable levels of copper and zinc, while levels of nickel and chromium were below detection levels. Levels of copper were about one-third the ERL level of 34 mg/dry kg. Zinc levels were above the ERL level of 150 mg/dry kg in one of the three replicates. In comparison to the mussel tissue analyzed from Catalina Island, both copper and zinc levels were markedly less at the Mandalay site suggesting that the mussel tissues actually depurated during the three months they lived offshore of the Mandalay generating station discharge.

Mussel tissue analyzed from nearby Ormond Beach in 1991 had a copper concentration of 55 mg/wet kg (Ogden 1991). In 1988, California State Mussel Watch (CSMW) found levels of copper between 16 and 23 mg/dry kg in resident California mussels (*Mytilus californianus*) collected in Santa Monica Bay (SWRCB 1990). The same study also found levels of copper between 3 and 29 mg/wet kg in transplanted California mussels collected in nearby Marina Del Rey. An overview of copper concentrations in whole bay mussels conducted by CSMW and NOAA in the Southern California Bight from 1980 to 1986 found copper tissue levels ranging from 4.0 to 120 mg/dry kg (NOAA 1991c). One conclusion was that copper appeared to be a contaminant in mussels principally near major recreational and industrial harbors, and secondarily near smaller harbors. The relatively high concentrations of copper and especially zinc found in mussels at the west end of Catalina was unexpected. The prevailing currents are to the south and there is no land to the north for more than 60 km, which should have resulted in relatively pristine conditions at the site where the mussels were collected.

In the same CSMW and NOAA studies, zinc concentrations ranged from 80 to 560 mg/dry kg. In 2001, maximum replicate zinc concentration in the study area was 260 mg/dry kg.

Mussel tissue metal levels were within ranges of those found in other studies indicating that there is no major source of metals in the study area.

## BIOLOGICAL MONITORING

### Benthic Infauna

The infauna community in the study area in 2001 was comprised primarily of small annelid worms, arthropods, mollusks, nemertean worms, and Pacific sand dollars. Abundance and species richness were similar among three of the stations (Station B1, at the discharge, Station B2, immediately downcoast of the discharge, and Station B5, farthest upcoast). They were considerably lower at Station B3, just upcoast of the discharge, and at Station B4, farthest downcoast. Abundance averaged 232 individuals per station (5,808 individuals/m<sup>2</sup>), with an average of 29 species per station. Species diversity was highest at Station B5, where the number of species was greatest and abundance was moderate. Species diversity values were low for Stations B1 and B2 despite high species richness, because of strong numerical dominance of the communities by one species, the annelid *Apoprionospio pygmaea*. Biomass of infaunal organisms was high everywhere except at Station B3, due to the occurrence of large Pacific sand dollars. Species richness and abundance values for the discharge station were greater than the means for the study area, but species diversity and biomass values were below the means. The communities at the five stations were composed of mostly the same species, but with some differences in abundances of the top species.

Infaunal organisms reflect the substrate in which they live (Johnson 1970, Gray 1974). The coastline at the generating station is exposed to ocean swell from both the south and west, and the shallow subtidal sediments are routinely subject to disturbance from normal wave activity and, infrequently, to severe disturbance during storms. Sediments are generally coarse, due to the winnowing effect of moving water, and there is little organic matter. Usually, coarse sediments support smaller and less diverse infaunal communities than do finer sediments (Barnard 1963). Particle sorting also plays a role, with well-sorted sediments providing fewer ecological niches. The species occupying the nearshore habitat are adapted to both coarse sediment and nearly constant disruption of the substrate (Oliver et al. 1980). Although small, they are capable of reburying themselves quickly if dislodged. Their life history strategies, such as frequent and abundant production of young, allow them to rapidly repopulate habitat severely disrupted by winter storms.

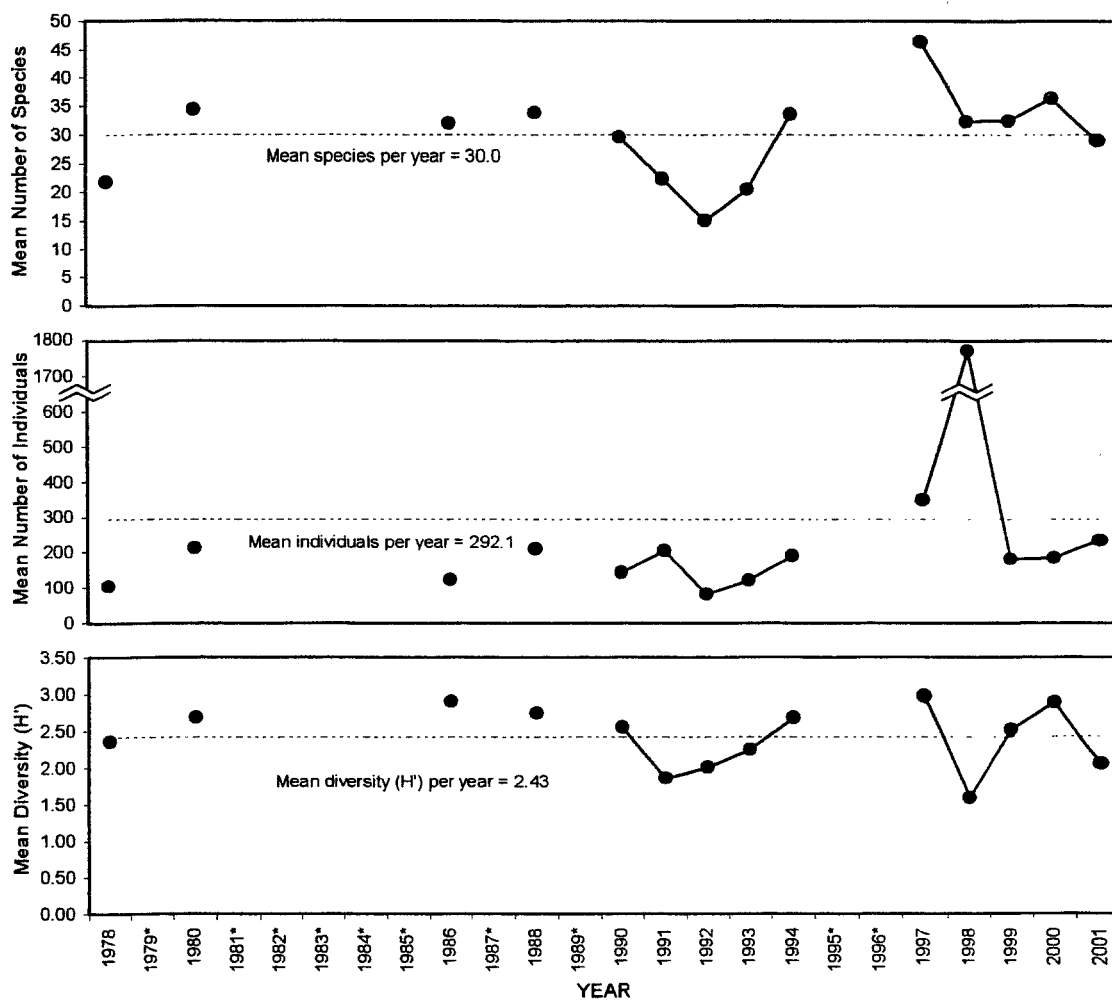
In the study area, abundance did not appear to relate to sediment characteristics. Sediments at Station B2, where abundance was greatest, were typical of the entire study area. Species richness and diversity, however, were greatest farthest upcoast where sediments were finest and most poorly sorted (although the differences between these sediments and the others were small). Reasons for the particularly low abundance and species richness at Station B3 and dominance of the communities at Stations B1 and B2 by one species (resulting in low species diversity values) were not clear. No pattern was apparent relative to the discharge.

The conspicuous difference between the communities at the five stations was the degree of dominance by the abundant species. *Apoprionospio pygmaea*, the most abundant species overall, was the dominant at only two stations, while *Mediomastus acutus*, the second most abundant species overall was the dominant at only one station. The high abundance of *M. acutus* at Station B5 was probably related to the presence of finer sediments at that station. The amphipod *Rhepoxynius menziesi* may also have shown substrate preference. This species is well adapted for rapid burrowing and is typically found where sediments are coarsest. It was more abundant at Station B1 than elsewhere, but it was still relatively abundant throughout the study area. Pacific sand dollars are important to the infaunal community because of their size and activities. They disturb the sediment as they position themselves on edge, but also stabilize the sediment by reducing erosion and provide protection from predators for other organisms (Merrill and Hobson 1970, Smith 1981). While intertidal sand dollar beds have been found to contain fewer species than the surrounding habitat, subtidal beds showed no difference in species richness but contained a slightly different community composition. Studies have suggested that sediment grain size does not influence site selection by larval sand dollars (Timko 1975, Smith 1981). Sand dollars appeared to show no sediment preference in 2001, although in 1999 and some other previous surveys offshore of Mandalay Beach they occurred where sediments were average to coarse. The species which comprised the infauna communities in 2001 are typical of the shallow nearshore environment (Barnard 1963, Dexter 1978).

Abundance at the five stations in 2001 was greater than in 2000 and most other previous surveys, but was slightly lower than the long-term mean (Figure 21) (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999a, 2000a; Ogden 1991-1993). Abundance in 1998 was extremely high, due in part to the unusual occurrence of a recent recruitment of Gould's beanclams (*Donax gouldii*) which comprised 58% of the abundance that year (MBC 1998). Slightly fewer species were collected in 2001 than in 2000, and the average per station species richness was just under the long-term mean. Species richness was particularly high in 1997, with a mean of 46 species per station compared with the long-term mean of 30 species. Species diversity in 2001 was also below the long-term mean. Diversity was low in 1998 due to numerical dominance of the community by Gould's beanclam.

Pacific sand dollars taken in the benthic collection in 2001 were larger and more numerous than in the 2000 survey. Sand dollar density reached 575 individuals/m<sup>2</sup> at Station B4, with an average biomass of 5.3 g per sand dollar for the survey area. Similar-sized sand dollars were taken in the 2001 trawl surveys, with more than 3,000 sand dollars collected in a single haul at Station T4

in summer (Appendices H-9 and H-11). Although Pacific sand dollars have been taken in the infauna samples in every survey but one since 1978, most have been juveniles; large adults occurred only in 1990, 1994, and 2000, with medium-sized individuals in 1999 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999a, 2000a; Ogden 1991-1993). Generally, when large sand dollars occur in the study area, they are taken in both infauna and trawl sampling. Sand dollars typically occur in dense aggregations, just seaward of the breaker line to depths of 12 m (Chia 1969, Merrill and Hobson 1970). Adults orient themselves semi-vertically in the sediment, only partially buried, and feed on suspended material swept by on currents. During calm conditions, they move shoreward into shallower water. When conditions are rough, they move into deeper water. Winter storms are occasionally severe enough to disrupt the sand dollar bed structure, after which the site is recolonized by juveniles recruited from other locations. In almost all years when both winter and summer fish trawls have been conducted, more sand dollars were taken in summer than in winter.



**Figure 21. Comparison of infaunal community parameters. Reliant Energy Mandalay generating station NPDES, 2001.**

In general, infauna abundance has been greatest immediately upcoast of the discharge, with an average abundance at that station of 499 individuals per survey (excluding Gould's beanclam, 280 individuals per survey) from 1978 to 2001 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999a, 2000a; Ogden 1991-1993). Average abundance for the discharge station was 203 individuals per survey, second highest of the five stations. Abundance for the study area averaged 246 individuals per station (6,150 individuals/m<sup>2</sup>), or 203 per station (5,065 individuals/m<sup>2</sup>) if Gould's

beancrabs are excluded. Average species richness has been very similar among stations. Species richness has been greatest at the discharge, with an average of 32 species per survey, compared with the long-term mean for the study area of 30 species per station. This suggests that the infaunal community is rather homogeneous throughout the study area. However, biological events such as settlement of new recruits, competition, or failure to reproduce can result in large spatial or temporal changes in abundance and community composition.

Only eight of the 11 most abundant species in the 2001 infaunal collection were among the 16 overall long-term dominant species (those that each comprised 1% or more of all individuals collected since 1978) (Appendix G-5). These include the annelids *Aporrhoe pygmaea*, *Mediomastus acutus*, and *Scoloplos armiger*, the amphipod *Rhepoxynius menziesi*, Pacific sand dollars, the nemertean *Carinoma mutabilis*, and the clams *Tellina modesta* and *Siliqua lucida*. Common species such as the cumacean *Diastylopsis tenuis* and the annelids *Spirophanes bombyx* and *Owenia collaris* occurred in 2001 but were not abundant. Gould's beancrab, the ostracod *Euphilomedes carcharodonta*, and the annelid *Pectinaria californiensis* have occasionally been very abundant but did not occur in 2001. Only two dominant species, the amphipod *Americhelidium shoemakeri* and the clam *Mactromeris catilliformis*, were more abundant than ever before; *M. catilliformis* was recorded in the study area for the first time in 2001. Despite these differences, however, comparison of the communities observed since 1978 shows that a core group of species has persisted.

The infaunal communities in the nearshore shallow subtidal environment off the generating station are typical of those in the Southern California Bight. Patchiness of occurrence is normal in this environment. Abundance and species richness have varied among stations, depending on oceanographic and sediment characteristics. The infaunal community in the study area in 2001 did not appear to be affected by the generating station operations.

### Fish and Macroinvertebrates

Queenfish, white croaker, and northern anchovy were the most abundant species collected in the 2001 NPDES trawl surveys off the Mandalay generating station. These three species were also the most abundant, and among the most frequently occurring, species collected since NPDES monitoring began in 1978 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). Since 1978, white croaker and queenfish have been collected in 24 of 25 trawl surveys in the study area, and combined, represent 85% of trawl-caught abundance. Northern anchovy has been collected in 20 of 25 trawl surveys, and has contributed nearly 7% to total abundance since 1978. Queenfish abundance in 2001 was the highest since summer 1994.

The persistence of the most abundant fish species since 1971 indicates a relatively stable assemblage typical of the nearshore, soft-bottom fish community in the Southern California Bight. Interannual fluctuations in abundance are most likely related to such factors as recruitment success, competition, predation, and large-scale oceanographic/climatological processes (e.g., El Niño and La Niña events). In 1999, effects from equatorial La Niña conditions extended northward, resulting in colder than normal water temperatures in southern California (NOAA 1999). This is likely the reason the historically abundant nearshore fish (white croaker, queenfish, and northern anchovy) were caught in much smaller numbers off Mandalay that year. Less-than-average numbers of these species were also recorded in trawl surveys off Seal Beach and Huntington Beach in 1999, as well (MBC 1999b, 1999c). The lowest abundance off Mandalay was recorded in 1997. El Niño conditions occurred off the California coast from mid-1997 through 1998, resulting in a northern latitude shift in many fish species (Lea and Rosenblatt 2000). In summer 1997, white croaker and queenfish were not only less abundant off Mandalay, but also were caught in low numbers off Seal Beach and Huntington Beach (MBC 1999b, 1999c). Northern anchovy were caught in low numbers off Mandalay and Huntington Beach, but were abundant off Seal Beach in 1999. Macroinvertebrates were also caught in low numbers in 1997 off Mandalay, Seal Beach, and Huntington Beach.

Walleye surfperch and white seaperch were fairly abundant in some of the first studies off Mandalay, but their occurrence and abundance since have been relatively low (Appendix H-12; IRC 1973, MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). Walleye surfperch rank sixth in trawl-caught abundance since 1978; however, 78% of the individuals were collected in 1978 and 1980. Similarly, 75% of white seaperch were caught in those two years, though they rank seventh in long-term abundance. A similar decrease was noted in shiner perch on the Palos Verdes shelf in the late 1970s (Allen and Moore 1996). While a decrease in sampling effort off Mandalay may have factored into the decline in abundance of walleye surfperch and white seaperch in trawl surveys, similar decreases in other nearshore areas of the Southern California Bight suggest some large-scale mechanism(s) affecting these populations (MBC 1999b, 1999c). Increasing ocean temperatures and a long-term decline in zooplankton biomass, especially in the 1970s, are possible factors for these declines (Allen and Moore 1996).

A total of 6,324 individual fish, representing 24 species and weighing nearly 87 kg were collected in the 2001 trawl surveys off the Mandalay generating station. Abundance in summer was over twice the abundance in winter, due largely to the higher number of queenfish collected in summer. Tube-snout was collected for the first time since studies began off Mandalay in 1971 (IRC 1973, MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). All other fish species collected in 2001 were collected in previous surveys in the study area (Table 16 and Appendix H-12).

**Table 16. The 20 most abundant fish species taken during trawl surveys, 1978 - 2001. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Year													Total	Percent
	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1999	2000	2001		
white croaker	6713	8446	1464	1150	1592	2291	2756	3043	7237	20	363	5363	1033	41471	49.5
queenfish	966	4889	830	195	957	1341	6049	3009	5483	-	76	1352	4630	29777	35.6
northern anchovy	1476	494	2	52	88	359	1469	159	115	-	640	256	383	5493	6.6
barred surfperch	210	172	46	223	38	95	29	115	41	18	1	33	9	1030	1.2
speckled sanddab	36	8	40	64	76	217	4	75	16	7	143	219	38	943	1.1
walleye surfperch	335	340	8	18	-	50	5	26	28	1	1	16	37	865	1.0
white seaperch	245	321	2	17	18	26	5	5	80	12	25	-	1	757	0.9
shiner perch	107	24	-	4	33	63	4	58	88	17	190	42	11	641	0.8
thornback	27	21	12	16	6	56	4	167	2	3	13	14	6	347	0.4
kelp pipefish	-	-	-	-	-	-	-	-	-	-	80	149	79	308	0.4
California halibut	25	54	66	58	21	27	1	8	11	-	2	5	1	279	0.3
California corbina	15	3	79	-	-	3	2	33	19	-	2	73	24	253	0.3
yellowfin croaker	2	-	11	1	-	1	-	79	50	-	-	-	3	147	0.2
barcheek pipefish	3	-	-	77	5	-	-	-	58	-	-	-	-	143	0.2
fantail sole	-	10	17	10	1	3	1	1	5	1	39	27	1	116	0.1
basketweave cusk-eel	1	3	9	-	8	45	-	28	4	-	1	5	-	104	0.1
English sole	22	8	5	49	7	-	-	1	4	1	7	-	-	104	0.1
shovelnose guitarfish	6	11	6	22	13	18	-	19	2	-	1	2	-	100	0.1
pipefish spp	-	6	17	-	-	18	11	25	-	-	-	-	-	77	0.1
hornyhead turbot	8	17	-	-	-	31	-	-	3	-	1	9	2	71	0.1
Survey totals															
Number of individuals	10299	14986	2648	2009	2896	4674	10399	6892	13296	89	1597	7616	6324	83725	
Number of species	41	35	29	24	23	30	21	28	33	10	25	22	24	63	
Total number of trawls	28	24	12	12	16	16	16	16	16	8	16	16	16		
Seasons sampled	2	2	2	2	2	2	2	2	2	1	2	2	2		
Stations/Replicates	14/1	12/1	3/2	3/2	4/2	4/2	4/2	4/2	4/2	4/2	4/2				

Queenfish was the most abundant fish species captured during the 2001 trawls, comprising over 73% of the total catch. Over 83% of the queenfish collected in 2001 occurred in summer trawls. Queenfish is the second most abundant species taken in the area since NPDES sampling began in 1978 (Table 16, Appendix H-12). In two-thirds of the sampling years, queenfish abundance was higher in summer than in winter. Queenfish are nearshore schooling fish, and abundance has been variable between seasons and among years. Most queenfish are found over sandy bottoms from the surf line out to about 23 m (75 ft) and in bays, sloughs, and around pilings (Eschmeyer et al. 1983, Love 1996). Queenfish school by day and disperse to deeper water at night where they actively feed on crustaceans and small fish. In 2001, larvae, juveniles, and adults were taken in trawls.

Queenfish mature at about one year and approximately 110 mm SL, though mature fish as small as 100 mm SL are occasionally found (DeMartini and Fountain 1981). Off Los Angeles,

spawning occurs from April into August (Goldberg 1976). In winter 2001, measured queenfish ranged in size from 40 to 138 mm SL, with most between 50 and 70 mm (Figure 14). Therefore, almost all of the queenfish were recently spawned juveniles. Only one queenfish taken measured greater than 100 mm SL, a 138-mm individual. In summer, the queenfish size distribution was unimodal, with one-half of the measured individuals in the 80 mm size class, corresponding to fish in the latter half of their first year. Twenty-nine queenfish measuring 110 mm SL or larger were collected in summer, corresponding to fish with reproductive capability. Off Mandalay, more juveniles are usually caught in winter than in summer, and more mature individuals are usually collected in summer surveys (MBC 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993).

White croaker was the dominant species in winter 2001, but second most abundant during the study year, accounting for 16% of the total catch. Nearly 88% of the white croaker collected in 2001 occurred in winter trawls. Nearly one-half of all fish collected in trawls off the generating station since 1978 were white croaker (Table 16, Appendix H-12). This is only the second time in 12 sampling years when white croaker abundance in winter was higher than in summer. Similar to queenfish, abundance of white croaker has typically varied between replicates and seasons and among locations. This variability reflects the transient nature of schooling species. White croaker is typically abundant over sandy nearshore areas (Hobson and Chess 1976, Allen and DeMartini 1983) preferring inshore areas to 22 m (Love et al. 1984). In a demersal fish survey of the Southern California Bight in summer 1994, only nine white croaker were collected in 45 trawls between Pt. Dume and Pt. Conception at depths of 10 to 200 m (Allen et al. 1998). It should be noted, however, that most of these trawls were conducted deeper than the preferred depth range of this species. White croaker are primarily nocturnal and tend to occur inshore during the day in schools, remaining nearshore at night to feed on bottom-dwelling polychaetes and crustaceans (Ware 1979, Allen 1982). Juveniles (less than 130 mm SL) are usually limited to shallow nearshore areas and embayments, which they may use as nursery grounds. In 2001, larvae, juveniles, and adults occurred in the NPDES trawl surveys.

White croaker mature at approximately one year at about 120 to 130 mm SL (Love et al. 1984). Although some spawning occurs year-round, most white croaker spawn from January through March. In winter 2001, most measured white croaker were in the 40 to 50 mm size class, corresponding to young-of-the-year (YOTY) fish (Figure 15). In summer, white croaker size distribution was unimodal, with most measured fish between 60 and 80 mm SL, again corresponding to fish in their first year. Only six white croaker greater than 130 mm SL were measured in 2001; three in both winter and summer. Off the generating station, more juveniles are usually collected in winter, and more mature individuals are usually found in summer, similar to queenfish (MBC 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). However, in 1991 and 1994, large numbers of YOTY were collected during summer surveys.

Northern anchovy was the third most abundant species in 2001, accounting for 6% of the total catch. Nearly two-thirds of northern anchovy were collected in summer. It has been present in surveys every year but one since 1978, although not always during both seasons (Table 16, Appendix H-12). In two-thirds of the sampling years, abundance was higher in summer than in winter. Northern anchovy is a schooling species that maintains tight schools during the day, feeding in the water column. It is common in the Southern California Bight and is one of the species most frequently captured in sampling conducted by otter trawls and other trawled gear, indicating that it is rather evenly distributed over the mainland shelf of southern California. It is usually among the most abundant and common species in summer surveys in the study area. In a demersal fish survey of the Southern California Bight in summer 1994, 280 northern anchovy were collected in 45 trawls between Pt. Dume and Pt. Conception at depths of 10 to 200 m (Allen et al. 1998). In that Bight-wide survey, 92% of trawl-caught northern anchovy were collected on the outer shelf at depths of 101 to 200 m. Northern anchovy is also an important component of the ecosystem in southern California. Anchovy eggs and larvae are prey for vertebrate and invertebrate planktivores (Leet et al. 1992). Juveniles in nearshore areas support a variety of predators, including birds and other fish. Northern anchovy is also important commercially; it is used in conversion to meal, oil, and protein products,

and as live bait (Leet et al. 1992). In 2001, larvae, juveniles, and adults occurred in the NPDES trawl surveys.

Northern anchovy mature at one to two years at a length of 80 to 130 mm SL (Hunter and Macewitz 1980) and reach 50 to 60 mm in the first two months of life (Sakagawa and Kimura 1976). Although northern anchovy may spawn throughout the year, most spawning occurs from January to May (Brewer 1978, Hunter and Macewitz 1980). In winter 2001, the distribution of measured northern anchovy was unimodal, with most measured fish in the 60 and 70 mm size classes, corresponding to YOTY fish (Figure 16). A few northern anchovy collected in winter were larger than 80 mm, and these fish may have been reproductively mature. In summer 2001, the size distribution was again unimodal, with most measured fish were between 90 and 110 mm SL, corresponding to one-year-old fish. Some YOTY were collected in summer, as well. Juvenile northern anchovy are typically found in nearshore areas and embayments and probably use these areas as nursery grounds (Allen and DeMartini 1983) while larger adults usually form schools offshore.

The fourth most abundant species in 2001 was kelp pipefish, accounting for almost 2% of the total catch. Kelp pipefish has only been recorded in NPDES surveys off Mandalay since 1999, but unidentified pipefish (*Syngnathus* spp.) have been taken occasionally since 1980 (Table 16, Appendix H-12). Identification aids for species in this genus have improved in recent years. It is probable that most pipefish captured in the same area prior to 1999 were also kelp pipefish. Nonetheless, this species ranks tenth in overall abundance since 1978. Kelp pipefish are found to a depth of about 15 m (50 ft), primarily in kelp beds (Eschmeyer et al. 1983).

The remaining 20 species collected in 2001 each comprised less than 1% of the overall abundance. Most species taken in 2001 are among a core group of fishes that are consistently taken in otter trawl surveys in the nearshore regions of the Southern California Bight (Allen 1982, Love et al. 1986, Allen and Herbinson 1991). Tube-snout, collected for the first time off the generating station since monitoring began, ranges from Sitka, Alaska, to Pt. Rompiente, Baja California (Miller and Lea 1972). Tube-snouts have been observed in loose schools in kelp beds, near eelgrass, in rocky crevices, and over sand bottom to depths of about 30.5 m (100 ft) (Limbaugh 1962). A dense school of tube-snouts photographed off Santa Rosa Island in 1950 was estimated to be one-quarter mile wide and about 12 m (40 ft) deep (Limbaugh 1962).

Total abundance has varied considerably in seasonal trawl surveys offshore of the Mandalay generating station, from a low of 89 individuals in 1997 to a high of 13,296 individuals in 1994 (Table 16). It should be noted, however, that only eight trawls were performed in 1997, compared with 12 to 28 in all other years. The number of fish collected per trawl in winter 2001 (242 individuals) was slightly lower than the long-term winter average (265 fish per trawl). In summer 2001, the number of fish per trawl (549 individuals) was slightly higher than the long-term summer average (515 fish per trawl). Variation in abundance has been attributed primarily to the presence or absence of the long-term dominant species: white croaker, queenfish and northern anchovy, all of which are schooling species. In 10 of the 12 two-season survey years, fish abundance offshore of the Mandalay generating station discharge has been greater in summer, when day length, water temperature, and productivity are at their highest (Appendix H-12).

Like abundance, species richness has varied considerably since 1978. In 2001, 24 fish species were collected, slightly below the long-term mean of 28 species from the twelve survey years when both seasons were sampled (Table 16). Species richness has been higher during summer in 11 of 12 two-season survey years since 1978 (Appendix H-12). Species richness was highest in 1978 and 1980, when there was increased sampling effort. The number of species collected in winter 2001 (13) was below the average for the last nine years (16) when seasonal sampling effort was the same among years. In summer 2001, the number of species (22) was above the nine-year summer average (20). As during previous years, Shannon-Wiener diversity ( $H'$ ) 2001 was highly variable among stations and between seasons (Table 10). In 2001, lower species

diversity in summer resulted from the dominance of queenfish at Stations T2, T3, and T4. In winter 2001, queenfish and white croaker were caught in somewhat similar numbers, resulting in higher H' values than in summer. In 1999 and 2000, higher overall diversity in winter resulted from the overwhelming dominance of white croaker and/or northern anchovy in summer surveys (MBC 1999a, 2000a). In 1994, diversity in winter and summer was nearly identical (MBC 1994).

Fish biomass in winter 2001 (22.0 kg) was higher than in winter 2000 (13.1 kg), but below the long-term winter average since 1990 (32.6 kg) (Appendix H-12). In summer 2001, fish biomass (65.1 kg) was less than one-half the biomass from last summer (146.1 kg), and just below the summer average (69.1 kg). In 2001, higher biomass in summer resulted from the large numbers of queenfish and one individual Pacific angel shark weighing 11.3 kg. In 2000, white croaker and Pacific angel shark accounted for 61% of total biomass. In 11 of the 12 winter/summer surveys, fish biomass offshore of the Mandalay generating station discharge has been greatest in summer.

Off Mandalay, four trawls each are performed upcoast (Stations T1 and T2) and downcoast (Stations T3 and T4) of the generating station. In winter 2001, abundance was highest upcoast, while in summer it was highest downcoast. Since 1990, abundance in winter has been highest upcoast of the generating station in six of eight surveys, and highest at one of the discharge stations (Stations T2 or T3) in only two of eight surveys (MBC 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). In summer surveys, highest abundance has occurred upcoast during five years and downcoast during four years. However, highest abundance in summer generally occurs at one of the discharge stations. The lack of clear distribution patterns in the study area is a function of the schooling nature and patchy distribution of the normally abundant species off the generating station.

In 2001, macroinvertebrate species richness was similar to that of the last nine years (when sampling effort was the same) (MBC 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). On average, eight invertebrate species are collected each winter and each summer off Mandalay. The seven species collected in winter 2001 was slightly below this, while species richness in summer 2001 (9) was slightly higher than the average. Invertebrate abundance, however, was well above the nine-year seasonal averages. Abundance in winter 2001 was the highest on record for winter and nearly four times the average. Abundance in summer 2001 was the third-highest on record for summer and nearly twice the average. Macroinvertebrate biomass in 2001 (63.1 kg) was the highest since monitoring began, with Pacific sand dollar contributing 95% to the total.

Pacific sand dollar comprised 87% of the winter catch and almost 97% of the summer catch in 2001, and has been caught in high numbers off Mandalay the last three years, particularly in summer. Blackspotted bay shrimp accounted for almost 11% of winter abundance and 3% of the summer catch in 2001. These two species have been the most abundant macroinvertebrates in the study area in 15 of 17 trawl surveys since 1990, and 20 of 25 surveys since 1978 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). A large recruitment of Pacific sand dollars occurred off Mandalay between the summer 1997 and winter 1999 trawl surveys. Since then, abundance of this species in trawls has increased in winter surveys, and decreased in summer surveys. Average size of the sand dollars off Mandalay increased from 0.13 and 0.12 kg per 100 individuals in winter and summer 1999 to 0.18 and 0.26 kg per 100 individuals in winter and summer 2000. Since last year, average size of the sand dollars collected by trawl doubled to 0.40 and 0.56 kg in winter and summer 2001. Erratic recruitment is common in this species (Timko 1975), and although the reproductive strategy of Pacific sand dollar is one of dispersal, larval settlement is often highest within or adjacent to existing sand dollar beds which already contain up to several hundred adults per square meter, perhaps in response to a chemical cue from the adults (Highsmith 1982).

Blackspotted bay shrimp has been the most abundant macroinvertebrate in four winter surveys and two summer surveys since 1978 (IRC MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997, 1999a, 2000a; Ogden 1991-1993). This species is common in trawl surveys at other locations in southern California, and plays an important role in the coastal food web (MBC 1999b, 1999c).

Blackspotted bay shrimp prefers mud and sand bottoms, feeding on small epibenthic and benthic fauna. In turn, blackspotted bay shrimp are preyed on by a number of fish, including Pacific staghorn sculpin (*Leptocottus armatus*) and brown smoothhound (*Mustelus henlei*) (Siegfried 1989). Annual abundance off some areas of California has varied widely, sometimes by more than tenfold (Siegfried 1989). All macroinvertebrate species collected in trawls in 2001 are common in the nearshore waters of southern California.

Fish and macroinvertebrate species composition in 2001 were similar to those in past surveys in the study area. Occasional high fish abundance and biomass resulted from the capture of large numbers of schooling fish (e.g. queenfish, white croaker, and/or northern anchovy) or large individuals, such as Pacific angel shark. No pattern of fish or macroinvertebrate distribution was evident in relation to the discharge of the Mandalay generating station.

### Impingement

Fish impingement surveys to evaluate fish loss were conducted at Mandalay generating station during one heat treatment and two normal operation surveys. In these surveys, six species of fish and 186 individuals weighing 9.58 kg were taken. In addition, five species of macroinvertebrates, representing 154 individuals and 4.90 kg were taken.

Water for the Mandalay generating station travels down Edison Canal from a back channel of Channel Islands Harbor. Many of the fish impinged are typical inhabitants of a bay environment, living on the mud bottom, and feeding on prey items found on or in the mud. Most of these species utilize the bay environment as nursery areas; most of the individuals were small, indicating that Channel Islands Harbor provides a nursery area for these species, similar to what is seen in Long Beach Harbor and Alamitos Bay (MBC 2000b, 2000c). Fishes impinged during normal operations and heat treatments are removed from the intake canal that supplies water to the generating station. Water flow into the pumps is not constrained by a concrete enclosure, but is open to the main body of the canal. The procedure by which heated water is recirculated during the heat treatment procedure allows the fish present in the canal to swim away from the hot water, which minimizes the number of individuals impinged on the screening system. The invertebrates impinged also are not constrained, and relatively few invertebrates were taken during impingement surveys. Thus, it appears that fish and invertebrate loss during normal operations and heat treatments at Mandalay generating station is negligible, and the generating station is having little effect on the nekton of Channel Islands Harbor.

### CONCLUSIONS

In 2001, there was a slight elevation of surface water temperature during both surveys at the surf-zone stations in the vicinity and upcoast of the discharge channel. This pattern appears to be common in the area and has been noted in prior surveys. Temperature increases were minor at offshore stations. The distribution of a thermal field around the discharge appeared to be a result of seasonal variation of local currents with a reduced tidal influence. Dissolved oxygen concentrations and pH at offshore stations were similar among stations and between tides, with no patterns relative to the discharge. Dissolved oxygen concentrations varied greatly at the offshore stations in summer due to a large plankton bloom. Hydrogen ion concentrations at surf-zone stations were also similar to the offshore values. All water quality measurements were within ranges recorded in the study area and within the Southern California Bight in past studies, and only minor local effects could be attributed to the discharge at the generating station.

In 2001, sediments were coarsest off the generating station discharge canal, and finest at the station furthest upcoast. The relatively large amount of fine material collected at the upcoast control station is likely discharged from the Santa Clara River, less than one nautical mile upcoast from that station. Overall, sediment characteristics were similar to those recorded in previous

surveys. Natural causes, such as sediment deposition and transport by nearshore currents, are likely responsible for interannual variation in sediment characteristics in the study area.

Sediment concentrations of all metals in 2001 were within the ranges found in sediments within the Southern California Bight and were lower than or comparable to levels found by the National Oceanographic and Atmospheric Administration at other sandy, offshore sites in southern California. Concentrations of metals in the study area have consistently been below levels determined to be potentially toxic to benthic organisms. There is no indication that operation of the generating station has had an appreciable effect on sediment metal levels.

In 2001, mean copper and zinc concentrations from mussel tissue collected near the Mandalay generating station were similar or less than the concentrations noted at the reference station. Nickel and chromium were not detected in the mussel tissue. All concentrations were similar to those seen in other studies of mussels in the Southern California Bight.

The infauna communities in the study area in 2001 were similar to those found in previous studies conducted since 1978. Abundance was greatest immediately downcoast of the discharge, while species richness and diversity were greatest farthest upcoast of the discharge. Abundance and species richness values at the discharge station were near the average for the study area. No patterns in infaunal community parameters were apparent relative to the discharge.

In 2001, fish and macroinvertebrate species composition were similar to those in prior surveys, and the most abundant species in winter and summer were the long-term dominants in the study area. No pattern in the distribution of fish and macroinvertebrates was evident in relation to the generating station, and there is no indication plant operations are adversely affecting the fish and macroinvertebrate populations offshore the Mandalay generating station.

Normal operation and heat treatment fish surveys indicate that Mandalay generating station is having a negligible effect on the nekton populations of Channel Islands Harbor.

The overall results of the 2001 NPDES monitoring program indicated that operation of the Reliant Energy Mandalay generating station had no detectable effects on the beneficial uses of the receiving waters.

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**PERSONAL COMMUNICATION**

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## **APPENDIX A**

### **Receiving water monitoring specifications**

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## V. RECEIVING WATER MONITORING

### A. Receiving Water

1. Pursuant to the Code of Federal Regulations [40 CFR § 122.41(j) and §122.48(b)], the monitoring program for a discharger receiving a NPDES permit must determine compliance with NPDES permit conditions, and demonstrate that State water quality standards are met.
2. Since compliance monitoring focuses on the effects of point source discharge, it is not designed to assess impacts from other sources of pollution (e.g., nonpoint source runoff, aerial fallout) nor to evaluate the current status of important ecological resources on a regional basis.

### B. Regional Database

1. Several efforts are underway to develop and implement a comprehensive regional monitoring program for the Southern California Bight. These efforts

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have the support and participation from regulatory agencies, dischargers, and environmental groups. The goal is to establish a regional program to address public health concerns, monitor trends in natural resources and nearshore habitats, and assess regional impacts from all contaminant sources.

2. Two pilot regional monitoring programs were conducted; one during the summer of 1994 and another in 1998. The purpose of the pilot programs were to test an alternative sampling design that combines elements of compliance monitoring with a broader regional assessment approach. The pilot program was designed by USEPA, the State Board, and three Boards (Los Angeles, Santa Ana, and San Diego) in conjunction with the Southern California Coastal Water Research Project and participating discharger agencies.

The pilot regional monitoring programs included the following components: microbiology; water quality; sediment chemistry; sediment toxicity testing; benthic infauna; demersal fish; and bioaccumulation.

3. The two pilot regional monitoring programs were funded primarily, by resource exchanges with the participating discharger agencies. During the year when pilot regional monitoring was scheduled, USEPA and this Regional Board eliminated portions of the routine compliance monitoring programs for that year, while retaining certain critical compliance monitoring elements. A certain percentage of the traditional sampling sites were also retained to maintain continuity of the historical record and to allow comparison of different sampling designs. The exchanged resources were redirected to complete sampling within the regional monitoring program design. Thus, the Discharger's overall level of effort for the 1994 and 1998 pilot programs remained approximately the same as the compliance monitoring programs.
4. Given the apparent benefits realized by the first two regional monitoring programs, it is probable that similar comprehensive sampling efforts will be repeated for the California Bight at periodic intervals (perhaps every four or five years). At the present time, it appears likely that the next regional monitoring program will be attempted during the summer of 2002 - 2003.
5. We anticipate that future regional monitoring programs will be funded in a similar manner. Revisions to the routine compliance monitoring program will be made under the discretion of the USEPA and this Regional Board as necessary to accomplish this goal; and may include resource exchanges in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.
6. The compliance monitoring programs for the Mandalay Generating Station, and other major ocean dischargers will serve as the framework for the regional

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monitoring program. However, substantial changes to these programs may be required to fulfill the goals of regional monitoring, while retaining the compliance monitoring component required to evaluate the potential impacts from NPDES discharges. Revisions to the existing program will be made under the discretion of the USEPA and this Regional Board as necessary to accomplish this goal; and may include a reduction or increase in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.

C. Monitoring for Algicide Spraying

The Discharger periodically sprays the banks of the Mandalay Intake Canal with an algicide to control algal growth in the intake canal. The Discharger shall notify the Regional Board at least two weeks prior to each application of algicide. Water samples shall be collected at a minimum of three locations (Wooley Road, 5<sup>th</sup> Street and Unocal Bridge, or other locations subject to approval by the Executive Officer) and analyzed for total residual oxidant concentrations. The Discharger also shall conduct visual observations of the canal following algicide applications to assess the effectiveness of the spraying program in controlling algal growth and to observe any unusual mortality of fish or invertebrates. The Discharger shall report the results of sample analysis and visual observations, as well as a description of the amounts and locations of all algicide applications, in the appropriate monthly monitoring report to the Regional Board.

D. Receiving Water Monitoring

The receiving water monitoring program shall consist of periodic biological surveys of the area surrounding the discharge, and shall include studies of those physical-chemical characteristics of the receiving water which may be impacted by the discharge.

Location of Sampling Stations (see Attached Figure 1):

1. Receiving water stations in the surf zone shall be located as follows:

- a. Station RW1 - 1180 feet upcoast of the discharge channel.
- b. Station RW2 - 1180 feet downcoast of the discharge channel.
- c. Station RW3 - 2360 feet upcoast of the discharge channel.
- d. Station RW4 - 2360 feet downcoast of the discharge channel.
- e. Station RW5 - At the discharge channel.

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2. Receiving water stations offshore of the discharge area shall be located as follows:
  - a. Station RW6 - directly offshore of station RW13 at a depth of 30 feet.
  - b. Station RW7 - directly offshore of station RW16 at a depth of 30 feet.
  - c. Station RW8 - directly offshore of station RW11 at a depth of 30 feet.
  - d. Station RW9 - directly offshore of station RW17 at a depth of 30 feet.
  - e. Station RW10 - directly offshore of station RW12 at a depth of 30 feet.
  - f. Station RW11 - directly offshore of station RW5 at a depth of 20 feet.
  - g. Station RW12 - directly offshore of station RW4 at a depth of 20 feet.
  - h. Station RW13 - directly offshore of station RW3 at a depth of 20 feet.
  - i. Station RW14 - 5,910 feet downcoast of the discharge channel at a depth of 20 feet.
  - j. Station RW15 - 5,910 feet upcoast of the discharge channel at a depth of 20 feet.
  - k. Station RW16 - directly offshore of station RW1 at a depth of 20 feet.
  - l. Station RW17 - directly offshore of station RW2 at a depth of 20 feet.
3. Benthic stations shall be located as follows:
  - a. Station B1 shall be located directly beneath Station RW11.
  - b. Station B2 shall be located directly beneath Station RW12.
  - c. Station B3 shall be located directly beneath Station RW13.
  - d. Station B4 shall be located directly beneath Station RW14.
  - e. Station B5 shall be located directly beneath Station RW15.

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4. Trawling stations shall be located as follows:

- a. Station T1 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW15.
- b. Station T2 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW16.
- c. Station T3 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW17.
- d. Station T4 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW14.

E. Type and Frequency of Sampling:

1. Surface temperatures, dissolved oxygen levels and pH shall be measured semiannually (summer and winter) each year at Stations RW1 through RW5. All stations shall be sampled on both a flooding tide and an ebbing tide during each semiannual survey.
2. Temperature profiles shall be measured semiannually (summer and winter) each year at Stations RW6 through RW17 from surface to bottom at a minimum of one-meter intervals. Dissolved oxygen levels and pH shall be measured semiannually at least at the surface, mid-depth and bottom at each station. All stations shall be sampled on both a flooding tide and an ebbing tide during each semiannual survey.
3. Impingement sampling for fish and commercially important macroinvertebrates shall be conducted at least once every two months at intake Serial No. 002. Impingement sampling shall coincide with heat treatments for at least three of the six sampling events during the year.

Fish and macroinvertebrates shall be identified to the lowest possible taxon. For each intake point, data reported shall include numerical abundance of each fish and macroinvertebrate species, wet weight of each species (when combined weight of individuals in each species exceeds 0.2 kg), number of individuals in each 1-centimeter size class (based on standard length) for each species and total number of species collected. When large numbers of given species are collected, length/weight data need only be recorded for 50 individuals and total number and total weight may be estimated based on aliquots samples. Total fish impinged per heat treatment or sampling event shall be reported and data shall be expressed per unit volume water entrained.

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4. Native California mussels (*Mytilus Californianus*) shall be collected during the summer from the discharge conduit, as close to the point of discharge as possible, for bioaccumulation monitoring. The mussels shall be collected and analyzed as described in Appendix A of the *California State Mussel Watch Marine Water Quality Monitoring Program 1985-86* (Water Quality Monitoring Report No. 87-2WQ). Mussel tissue shall be analyzed for copper, chromium, nickel, and zinc at a minimum.
5. Sampling by otter trawl shall be conducted semiannually (summer and winter) each year along transects at Stations T1 through T4. Trawls are specialized gear used in large open water areas of reservoirs, lakes, large rivers, estuaries, and offshore marine areas. They are used to gain information on a particular species of fish rather than on overall fish populations. The otter trawl is used to capture near-bottom and bottom fishes.
  - a. Trawl net dimensions shall be as follows:
    1. At least a 25 ft throat width.
    2. 1.5 in mesh-size (body).
    3. 0.5 in mesh-size (linear in the cod end).
  - b. Two replicate trawls shall be conducted at each station for a duration of 10 minutes each at a uniform speed between 2.0 and 2.5 knots.
  - c. The identity, size (standard length), wet weight, and number of fish in each trawl shall be reported. The number of fish affected by abnormal growth or disease, such as fin erosion, lesions, and papillomas, shall be reported. Fish species shall be reported in rank order of abundance and frequency of occurrence for each trawl. The Shannon-Wiener diversity index shall also be computed for each trawl.
  - d. All commercially important macroinvertebrates shall be identified, enumerated, and reported in the same manner as fish species.
6. Benthic sampling shall be conducted annually during the summer at Stations B1 through B5.

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- a. One liter sediment core samples shall be collected by divers at each of the benthic stations for biological examination and determination of biomass and diversity, and for sediment analyses. Four replicates shall be obtained at each station for benthic analyses, and each shall be analyzed separately. A fifth sample shall be taken at each station for sediment analyses and general description.
- b. Each benthic replicate sample shall be sieved through a 0.5 mm standard mesh screen. All organisms recovered shall be enumerated and identified to the lowest taxon possible. Infaunal organisms shall be reported as concentrations per liter for each replicate and each station. Total abundance, number of species and Shannon-Weiner diversity indices shall be calculated (using natural logs) for each replicate and each station.

Biomass shall be determined as the wet weight in grams or milligrams retained on a 0.5 millimeter screen per unit volume (e.g., 1 liter) of sediment. Biomass shall be reported for each major taxonomic group (e.g., polychaetes, crustaceans, mollusks) for each replicate and each station.

- c. Sediment grain size analyses shall be performed on each sediment sample (sufficiently detailed to calculate percent weight in relation to the size). Sub-samples (upper two centimeters) shall be taken from each sediment sample and analyzed for copper, chromium, nickel and zinc.
7. The following general observations or measurement at receiving water, benthic and trawl stations shall be reported:
    - a. Tidal stage, time, and date of monitoring.
    - b. General water conditions.
    - c. Color of the water.
    - d. Appearance of oil films or greases, or floatable materials.
    - e. Extent of visible turbidity or color patches.
    - f. Direction of tidal flow.
    - g. Description of odor, if any, of the receiving water.

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- h. Depth at each station for each sampling period.
  - i. Presence or absence of red tide.
  - j. Presence and activity of marine life.
  - k. Presence of the California Least Tern and California Brown Pelican.
- 8. During the discharge of calcareous material (excluding heat treatment discharge) to the receiving waters, the following observations or measurements shall be recorded and reported in the next monitoring report:
  - a. Date and times of discharge(s).
  - b. Estimate of volume and weight of discharge(s).
  - c. Composition of discharge(s).
  - d. General water conditions and weather conditions.
  - e. Appearance and extent of any oil films or grease, floatable material or odors.
  - f. Appearance and extent of visible turbidity or color patches.
  - g. Presence of marine life.
  - h. Presence and activity of the California least tern and the California brown pelican.

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## SUMMARY OF RECEIVING WATER MONITORING PROGRAM

<u>Constituent</u>	<u>Units</u>	<u>Stations</u>	<u>Type of Sample</u>	<u>Minimum Frequency of Analysis</u>
Temperature	°C	RW1-RW5	surface	semiannually (flood, ebb)
Temperature	°C	RW6-RW17	vertical profile	semiannually (flood, ebb)
Dissolved oxygen	mg/L	RW1-RW5	surface	semiannually (flood, ebb)
Dissolved oxygen	mg/L	RW6-RW17	vertical profile	semiannually (flood, ebb)
pH	pH Units	RW1-RW5	surface	semiannually (flood, ebb)
pH	pH Units	RW6-RW17	vertical profile	semiannually (flood, ebb)
Fish and macro Invertebrates	---	T1-T4	trawl	semiannually
Fish and macro Invertebrates	---	Intake Serial No. 002	impingement	bimonthly
Benthic Infauna	---	B1-B5	grab	annually
Sediments	---	B1-B5	grab	annually
Mussels	---	Discharge Serial No. 001	tissue	annually

The receiving water monitoring report containing the results of semiannual and annual monitoring shall be received at the Regional Board on March 1 of each year following the calendar year of data collection.

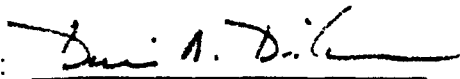
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VI. STORM WATER MONITORING AND REPORTING

The Discharger shall implement the Monitoring and Reporting Requirements for individual dischargers contained in the general permit for *Dischargers of Storm Water Associated with Industrial Activities* (State Board Order No. 97-030-DWQ) adopted on April 17, 1997. The monitoring reports shall be received at the Regional Board by July 1 of each year. Indicate in the report the Compliance File CI-2093.

Ordered by:



Dennis A. Dickinson  
Executive Officer

Date: April 26, 2001

/COD

T/22

79

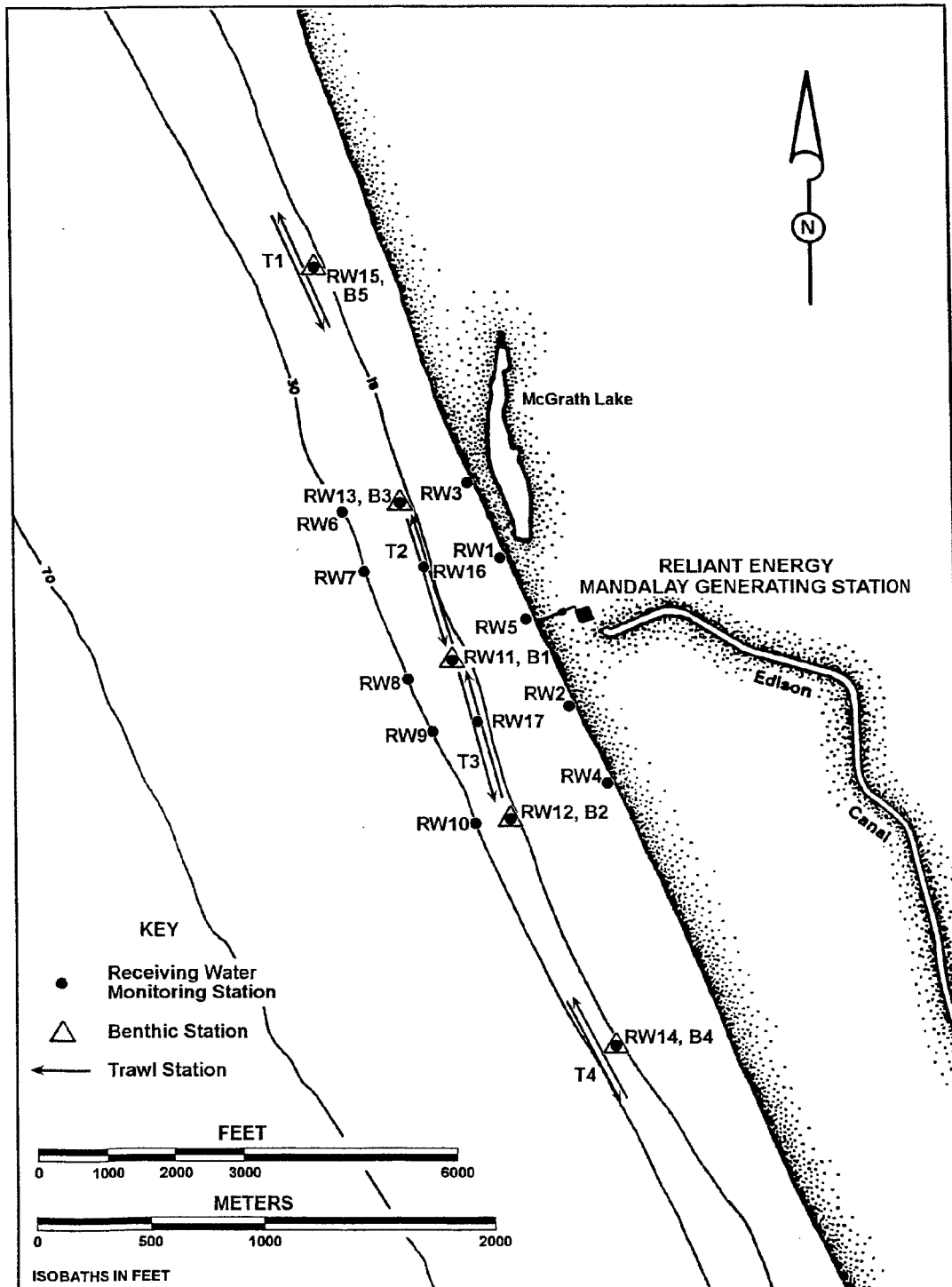


Figure 1. Locations of the sampling stations. Reliant Energy Mandalay Generating Station.

# **APPENDIX B**

## **Grain size techniques**

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## Appendix B. Grain size techniques.

### Sediment Grain Size Analysis

Analysis of sediment samples for size distribution characteristics are performed using two techniques. Sediments in the gravel size range ( $> 2.0$  mm in diameter) are analyzed using a series of standard sieves having screen openings of 0.5 phi increments (diameter in phi units =  $-\log_2$  diameter in mm, or =  $-\ln$  diameter in mm  $\div \ln 2$ ). The sand-silt-clay fraction of sediments [-1 phi through 4 phi (2.0 mm through 0.0625 mm) for sand], [4 phi through 8 phi (0.0625 mm through 0.004 mm) for silt, 8 phi and greater for clay (0.0039 mm and smaller)] is analyzed by laser light diffraction. The sample is suspended in a suspension column and continuously circulated through the laser beam. The laser beam passes through the sample where the suspended particles scatter incident light. Fourier optics collect diffracted light and focus it on to three sets of detectors. A composite, time-averaged diffraction pattern is measured by 126 detectors. Sizes are computed and summed into normal distribution classifications.

Laboratory data from the two methods are mathematically combined and entered into a computer program which calculates and prints size-distribution characteristics and plots both interval and cumulative frequency distribution curves.

Analysis of the plotted cumulative size frequency curves is performed as described by Inman (1952). The median, 5th, 16th, 84th, and 95th percentiles (converted to phi notation) of the sediment distribution curve is used to calculate mean grain size diameter, sorting coefficient, and measures of skewness and kurtosis. Where sediment distribution coincides with a normal distribution curve, the 16th and 84th percentiles represent diameters one standard deviation on either side of the mean. The following formulas are used in the calculations:

1. Mean Diameter ( $M_\phi$ ) is the average particle size in the central 68% of the distribution.

$$M_\phi = (\phi_{16} + \phi_{50} + \phi_{84}) / 3$$

2. Sorting ( $\sigma_\phi$ ) measures the uniformity (or non-uniformity) of particle quantities in each size category of the sediment distribution. A  $\sigma_\phi$  value under  $0.35\phi$  indicates that particles are very well sorted (i.e. sediments are primarily composed of a narrow range of size classes, or a single size class), while a value of over  $4.0\phi$  indicates that the sediments are extremely poorly sorted, or evenly distributed among size classes.

$$\sigma_\phi = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_5}{6.6}$$

3. Skewness ( $\alpha_\phi$ ) is a measure of the direction and extent of departure of the mean from the median (in a normal or symmetrical curve they coincide). In symmetrical curves,  $\alpha_\phi = 0.00$  with limits of  $-1.00$  and  $+1.00$ . Negative values indicate the particle distribution is skewed toward larger particle diameters, while positive values indicate the distribution is skewed toward smaller particle diameters.

$$\alpha_\phi = \frac{\phi_{16} + \phi_{84} - 2\phi_{50}}{2(\phi_{84} - \phi_{16})} + \frac{\phi_5 + \phi_{95} - 2\phi_{50}}{2(\phi_{95} - \phi_5)}$$

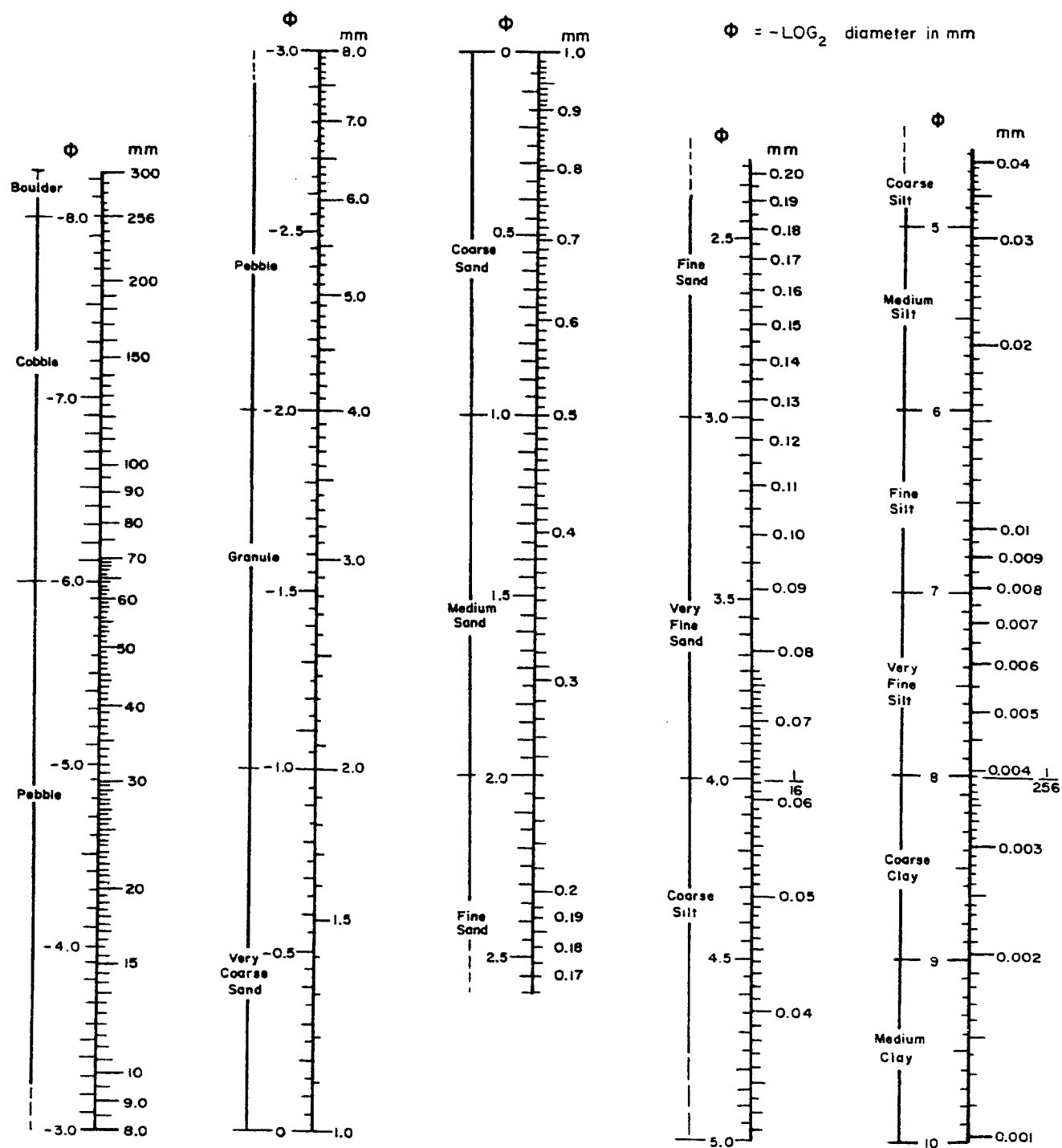
4. Kurtosis ( $\beta_\phi$ ) is a measure of how far the sediment distribution curve departs from a normal Gaussian shape at its peak. Curves with greater than normal amounts of sediment at their modes will be sharp or leptokurtic ( $\beta_\phi > 1$ ). Those with fatter tails and lower peaks than expected are termed platykurtic ( $\beta_\phi < 1$ ).  $\beta_\phi = 1.00$  for a normal curve. Curve category interpretations are based on Folk (1974).

$$\beta_\phi = \frac{\phi_{95} - \phi_5}{2.44(\phi_{75} - \phi_{25})}$$

### LITERATURE CITED

- Folk, R. L. 1974. Petrology of sedimentary rocks. Hemphill Publishing Co., Austin, TX. 182 p.
- Inman, D. L. 1952. Measures for describing the size distribution of sediments. J. Sed. Pet. 22:125-145.

Phi - Millimeter Conversion Figure



Measurement sorting values for a large number of sediments has suggested the following verbal classification scale for sorting:

$\sigma_1$ under .35 $\phi$ ,	very well sorted	1.0-2.0 $\phi$ ,	poorly sorted
.35-.50 $\phi$ ,	well sorted	2.0-4.0 $\phi$ ,	very poorly sorted
.50-.71 $\phi$ ,	moderately well sorted	over 4.0 $\phi$ ,	extremely poorly sorted
.71-1.0 $\phi$	moderately sorted		

## **APPENDIX C**

**Water quality parameters at each receiving water monitoring station**

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**Appendix C-1. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Reliant Energy Mandalay generating stations NPDES, winter 2001.**

	Depth (m)	Temp. (°C)		Oxygen (mg/l)		pH		Salinity (ppt)	
		FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
<b><u>Surf Zone</u></b>									
RW1	0	20.30	21.20	8.04	8.40	8.16	8.12	33.40	33.30
RW2	0	16.10	15.30	7.79	7.83	8.24	8.20	33.40	33.50
RW3	0	18.10	18.00	7.91	8.27	8.20	8.19	33.40	33.40
RW4	0	16.30	15.20	7.84	7.78	8.24	8.22	33.40	33.10
RW5	0	20.40	25.30	8.37	8.76	8.17	8.00	33.50	32.80
<b><u>Offshore</u></b>									
RW6	0	15.84	15.44	8.46	8.56	8.01	8.02	32.36	32.38
	1	15.81	15.43	8.51	8.51	8.01	8.02	32.43	32.40
	2	15.73	15.40	8.51	8.60	8.02	8.03	32.57	32.44
	3	15.70	15.25	8.50	8.75	8.02	8.03	32.62	32.68
	4	15.27	14.99	8.59	8.82	8.02	8.04	32.97	33.06
	5	14.64	14.85	8.73	8.84	8.02	8.05	33.36	33.17
	6	14.44	14.53	8.74	9.20	8.02	8.04	33.39	33.35
	7	14.38	14.51	8.87	9.10	8.02	8.02	33.39	33.37
	8	14.28	14.51	8.91	8.97	8.02	8.02	33.39	33.34
	9	14.24	14.42	8.88	8.92	8.01	8.02	33.40	33.36
	10	14.25	14.42	8.61	8.91	8.00	8.01	33.39	33.36
RW7	0	15.91	15.37	8.46	8.68	8.02	8.02	32.27	32.57
	1	15.88	15.37	8.44	8.73	8.02	8.02	32.34	32.57
	2	15.43	15.21	8.55	8.72	8.02	8.04	32.95	32.82
	3	14.89	15.01	8.62	8.77	8.02	8.06	33.24	33.13
	4	14.48	14.85	8.66	8.88	8.02	8.06	33.37	33.23
	5	14.39	14.78	8.68	9.11	8.03	8.06	33.40	33.26
	6	14.28	14.71	8.75	9.20	8.01	8.06	33.40	33.30
	7	14.27	14.53	8.77	9.25	8.01	8.04	33.40	33.35
	8	14.26	14.49	8.62	9.11	8.01	8.03	33.40	33.35
	9	14.26	14.46	8.52	8.86	8.01	8.02	33.39	33.35
	10	14.27	14.44	8.52	8.79	8.01	8.02	33.39	33.36
RW8	0	15.91	15.29	8.50	8.70	8.02	8.02	32.52	32.42
	1	15.90	15.26	8.46	8.70	8.02	8.02	32.53	32.47
	2	15.84	14.98	8.49	8.76	8.02	8.05	32.58	33.07
	3	15.69	14.93	8.52	8.78	8.02	8.06	32.76	33.14
	4	14.91	14.80	8.70	9.04	8.02	8.06	33.21	33.24
	5	14.57	14.75	8.70	9.19	8.03	8.06	33.34	33.28
	6	14.39	14.65	8.93	9.24	8.02	8.05	33.40	33.33
	7	14.37	14.52	8.93	9.22	8.01	8.04	33.40	33.35
	8	14.36	14.49	8.76	9.13	8.01	8.02	33.39	33.34
	9	14.36	14.41	8.73	8.94	8.01	8.02	33.38	33.36
	10	14.36	14.38	8.68	8.83	8.01	8.01	33.38	33.37
RW9	0	15.74	15.50	8.55	8.59	8.02	8.02	32.75	32.21
	1	15.72	15.47	8.53	8.57	8.02	8.02	32.74	32.27
	2	15.72	15.04	8.59	8.62	8.02	8.04	32.75	33.02
	3	15.73	14.77	8.59	8.65	8.03	8.06	32.81	33.26
	4	15.29	14.69	8.70	8.96	8.03	8.05	33.02	33.31
	5	14.62	14.62	8.78	9.11	8.04	8.04	33.37	33.32
	6	14.44	14.59	8.87	9.08	8.03	8.05	33.39	33.33
	7	14.42	14.56	9.03	9.03	8.02	8.04	33.38	33.33
	8	14.42	14.48	8.88	8.98	8.02	8.03	33.39	33.33
	9	14.41	14.46	8.77	8.96	8.02	8.02	33.37	33.35
	10	14.41	14.34	8.69	8.90	8.02	8.01	33.37	33.37
	11		14.35		8.84		8.01		33.37

Appendix C-1. (Cont.).

	Depth (m)	Temp. (°C)		Oxygen (mg/l)		pH		Salinity (ppt)	
		FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW10	0	15.27	15.40	8.80	8.63	8.04	8.02	32.99	31.90
	1	15.02	15.46	8.90	8.62	8.04	8.02	33.15	32.13
	2	14.91	15.55	8.94	8.56	8.05	8.02	33.21	32.77
	3	14.84	14.96	9.03	8.72	8.06	8.03	33.24	33.06
	4	14.73	14.80	9.12	8.75	8.06	8.06	33.29	33.20
	5	14.54	14.68	9.16	9.07	8.04	8.05	33.35	33.25
	6	14.50	14.58	9.20	9.13	8.03	8.04	33.36	33.30
	7	14.45	14.44	9.04	9.10	8.03	8.02	33.36	33.35
	8	14.40	14.34	8.89	8.96	8.02	8.01	33.37	33.38
	9	14.37	14.32	8.82	8.79	8.01	8.01	33.37	33.39
	10	14.35	14.31	8.74	8.63	8.01	8.00	33.38	33.39
	11	14.36		8.71		8.01		33.38	
RW11	0	16.02	16.20	8.26	8.34	8.01	8.00	33.09	32.96
	1	15.95	16.20	8.21	8.36	8.01	8.01	33.11	32.95
	2	15.92	16.15	8.30	8.36	8.02	8.00	33.09	32.94
	3	15.57	16.02	8.39	8.41	8.02	8.01	33.15	32.95
	4	15.51	14.96	8.36	8.64	8.02	8.03	33.15	33.16
	5	15.10	14.78	8.48	8.71	8.02	8.05	33.20	33.25
	6	14.77	14.78	8.53	8.75	8.02	8.04	33.28	33.26
RW12	7	14.57	14.70	8.68	8.94	8.03	8.04	33.38	33.26
	0	16.20	15.44	8.42	8.50	8.01	8.02	32.89	32.79
	1	16.12	15.44	8.42	8.53	8.01	8.02	32.93	32.69
	2	16.05	15.30	8.44	8.57	8.01	8.01	32.97	33.04
	3	15.94	15.01	8.46	8.61	8.00	8.02	33.00	33.15
	4	15.42	14.85	8.58	8.56	8.02	8.03	33.13	33.17
	5	15.12	14.66	8.57	8.72	8.02	8.02	33.22	33.23
	6	14.69	14.49	8.60	8.79	8.02	8.01	33.32	33.32
RW13	7	14.75	14.44	8.70	8.80	8.02	8.01	33.28	33.35
	8		14.45		8.69		8.02		33.35
	0	15.88	15.02	8.42	8.80	8.01	8.03	32.63	33.16
	1	15.88	14.96	8.38	8.74	8.01	8.02	32.81	33.18
	2	15.89	14.75	8.42	8.84	8.02	8.04	32.85	33.26
	3	15.71	14.69	8.49	8.86	8.02	8.04	32.96	33.27
	4	15.66	14.65	8.51	8.93	8.02	8.04	32.95	33.28
RW14	5	15.53	14.58	8.48	8.93	8.02	8.04	32.98	33.30
	6	15.22	14.61	8.58	8.92	8.02	8.03	33.07	33.30
	7	14.55	14.58	8.71	8.86	8.02	8.04	33.31	33.30
	0	15.52	15.29	8.55	8.57	8.00	8.02	33.03	32.66
	1	15.54	15.28	8.50	8.38	8.02	8.02	33.01	32.55
	2	15.44	15.28	8.56	8.63	8.02	8.02	33.07	32.67
	3	15.14	15.10	8.64	8.67	8.02	8.02	33.17	33.05
RW15	4	14.79	14.85	8.73	8.66	8.01	8.01	33.30	33.16
	5	14.51	14.60	8.67	8.65	8.01	8.02	33.37	33.28
	6	14.41	14.40	8.62	8.72	8.01	8.01	33.39	33.38
	7	14.41	14.38	8.66	8.77	8.01	8.01	33.38	33.39
	8		14.38		8.73		8.01		33.39
	0	15.48	15.23	8.66	8.80	8.02	8.02	32.16	32.23
	1	15.34	15.12	8.64	8.78	8.02	8.02	32.35	32.47
RW15	2	15.16	14.89	8.64	8.84	8.02	8.02	32.66	32.88
	3	14.94	14.67	8.71	8.87	8.03	8.02	32.96	33.25
	4	14.69	14.63	8.76	8.89	8.03	8.02	33.23	33.28
	5	14.53	14.63	8.85	8.95	8.02	8.03	33.32	33.27
	6	14.45	14.53	8.92	8.99	8.02	8.03	33.35	33.32
	7	14.45	14.53	8.79	8.91	8.02	8.02	33.35	33.32

Appendix C-1. (Cont.).

	Depth (m)	Temp. (°C)		Oxygen (mg/l)		pH		Salinity (ppt)	
		FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW16	0	18.18	15.97	7.90	8.42	7.99	8.00	32.96	32.90
	1	17.59	15.95	8.01	8.39	8.00	8.00	32.96	32.89
	2	16.76	15.93	8.20	8.40	8.02	8.00	32.99	32.90
	3	16.45	15.88	8.19	8.43	8.02	8.01	33.05	32.90
	4	14.59	15.91	8.84	8.43	8.02	8.01	33.49	32.90
	5	14.47	15.91	8.59	8.45	8.02	8.00	33.39	32.88
	6	14.47	15.91	8.63	8.44	8.03	8.01	33.38	32.88
	7	14.48	15.26	8.81	8.60	8.03	8.02	33.37	33.10
	8		14.86		8.66		8.02		33.43
RW17	0	16.11	15.61	8.25	8.45	8.00	8.00	32.89	32.95
	1	16.10	15.57	8.24	8.45	8.01	8.00	32.90	32.96
	2	15.48	15.53	8.54	8.48	8.02	8.01	33.10	32.96
	3	14.73	15.08	8.76	8.57	8.02	8.02	33.38	33.09
	4	14.62	15.11	8.75	8.56	8.02	8.02	33.32	33.09
	5	14.59	14.66	8.86	8.80	8.02	8.03	33.32	33.23
	6	14.59	14.69	8.90	8.72	8.02	8.03	33.32	33.21
	7	14.57	14.70	8.82	8.77	8.02	8.03	33.33	33.21

**Appendix C-2. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Reliant Energy Mandalay generating station NPDES, summer 2001.**

	Depth (m)	Temp. (°C)		Oxygen (mg/l)		pH		Salinity (ppt)	
		FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
<b>Surf Zone</b>									
RW1	0	21.65	20.84	7.03	7.06	7.88	8.01	33.57	33.66
RW2	0	15.48	17.03	8.02	7.89	7.96	8.04	33.67	33.71
RW3	0	18.75	18.80	7.52	7.40	7.95	8.06	33.63	33.69
RW4	0	15.56	17.11	8.31	7.73	8.00	8.04	33.45	33.71
RW5	0	26.61	25.99	4.85	5.65	7.69	7.80	33.40	33.53
<b>Offshore</b>									
RW6	0	14.30	16.40	5.97	8.78	7.84	8.11	33.52	33.49
	1	14.35	16.38	5.87	8.81	7.84	8.11	33.54	33.49
	2	13.71	16.24	6.01	8.84	7.78	8.09	33.56	33.52
	3	13.58	15.95	5.54	8.85	7.77	8.06	33.53	33.53
	4	13.47	15.74	5.40	8.62	7.77	8.05	33.54	33.52
	5	13.43	15.58	5.39	8.27	7.77	8.03	33.53	33.54
	6	13.39	14.17	5.41	8.46	7.77	7.93	33.53	33.60
	7	13.31	13.69	5.47	7.49	7.78	7.85	33.53	33.60
	8	13.27	13.41	5.56	6.61	7.79	7.84	33.53	33.57
	9	13.28	13.20	5.59	6.40	7.79	7.83	33.52	33.56
	10	13.29	13.14	5.54	6.19	7.79	7.81	33.52	33.55
	11	13.30		5.52		7.77		33.52	
RW7	0	14.78	16.49	5.91	9.36	7.90	8.13	33.48	33.49
	1	14.17	16.41	6.46	9.35	7.88	8.13	33.73	33.51
	2	13.64	16.34	6.15	9.30	7.79	8.12	33.57	33.51
	3	13.54	16.13	5.54	9.25	7.77	8.09	33.54	33.52
	4	13.49	15.94	5.48	9.05	7.77	8.07	33.53	33.58
	5	13.41	15.79	5.49	8.76	7.78	8.05	33.53	33.52
	6	13.34	15.40	5.53	8.57	7.79	8.03	33.53	33.57
	7	13.27	13.93	5.60	8.48	7.79	7.90	33.54	33.80
	8	13.25	13.64	5.69	7.20	7.79	7.85	33.53	33.57
	9	13.25	13.25	5.73	6.67	7.79	7.83	33.52	33.61
	10	13.27	13.13	5.69	6.38	7.80	7.81	33.52	33.56
	11		13.06		6.19		7.81		33.54
RW8	0	14.90	16.52	6.21	9.10	7.90	8.12	33.49	33.49
	1	14.83	16.45	6.43	9.12	7.89	8.11	33.52	33.50
	2	13.74	16.16	6.61	9.19	7.83	8.13	33.55	33.52
	3	13.48	16.03	5.82	9.29	7.80	8.12	33.56	33.51
	4	13.38	15.61	5.74	9.38	7.80	8.07	33.54	33.52
	5	13.27	14.88	5.75	9.08	7.80	7.98	33.54	33.57
	6	13.22	14.37	5.79	8.10	7.81	7.92	33.54	33.59
	7	13.21	13.73	5.83	7.26	7.81	7.87	33.53	33.64
	8	13.19	13.54	5.83	6.84	7.81	7.87	33.53	33.54
	9	13.19	13.28	5.80	6.61	7.81	7.83	33.53	33.58
	10	13.21	13.09	5.76	6.35	7.79	7.81	33.52	33.55
	11	13.21	13.09	5.69	6.09	7.80	7.79	33.52	33.54
RW9	0	14.63	16.53	6.33	10.47	7.87	8.20	33.51	33.49
	1	14.36	16.53	6.34	10.48	7.87	8.20	33.51	33.49
	2	13.61	16.46	6.25	10.55	7.82	8.20	33.61	33.50
	3	13.44	16.23	5.86	10.55	7.81	8.16	33.55	33.52
	4	13.32	15.83	5.85	10.21	7.81	8.11	33.54	33.55
	5	13.25	15.21	5.87	9.58	7.81	8.04	33.55	33.59
	6	13.22	14.61	5.89	8.50	7.82	7.97	33.54	33.56
	7	13.19	14.03	5.89	7.82	7.81	7.93	33.54	33.57
	8	13.17	13.60	5.90	7.40	7.81	7.88	33.53	33.56
	9	13.14	13.46	5.91	6.84	7.81	7.86	33.53	33.57
	10	13.14	13.31	5.85	6.55	7.80	7.83	33.52	33.56
	11	13.15	13.16	5.73	6.31	7.79	7.81	33.52	33.55

Appendix C-2. (Cont.).

	Depth (m)	Temp. (°C)		Oxygen (mg/l)		pH		Salinity (ppt)	
		FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW10	0	14.87	16.55	5.98	9.98	7.88	8.16	33.34	33.49
	1	14.32	16.51	6.78	10.03	7.90	8.17	33.72	33.50
	2	13.45	16.40	6.55	10.04	7.84	8.16	33.59	33.50
	3	13.33	16.18	6.02	10.05	7.81	8.15	33.56	33.52
	4	13.24	15.99	5.96	9.66	7.81	8.11	33.54	33.52
	5	13.21	15.93	5.97	9.13	7.82	8.08	33.53	33.51
	6	13.17	15.26	5.99	8.89	7.81	8.04	33.53	33.58
	7	13.11	13.89	6.01	8.48	7.81	7.93	33.54	33.55
	8	13.10	13.61	6.01	7.31	7.81	7.88	33.53	33.56
	9	13.08	13.59	6.02	6.76	7.81	7.87	33.53	33.54
	10	13.08	13.59	5.97	6.61	7.81	7.87	33.53	33.54
	11	13.09	13.59	5.84	6.53	7.80	7.87	33.52	33.53
RW11	0	15.25	16.64	6.90	9.27	7.96	8.12	33.49	33.49
	1	15.05	16.63	7.03	9.30	7.95	8.12	33.50	33.49
	2	14.16	16.59	7.14	9.33	7.89	8.13	33.68	33.50
	3	13.45	16.50	6.76	9.38	7.81	8.12	33.58	33.50
	4	13.28	16.43	6.07	9.42	7.81	8.11	33.56	33.50
	5	13.30	15.63	5.87	9.46	7.81	8.04	33.53	33.57
	6	13.29	14.57	5.92	9.21	7.81	7.92	33.53	33.75
	7		14.36		7.92		7.88		33.63
RW12	0	15.03	16.81	6.96	10.36	7.96	8.20	33.51	33.49
	1	14.59	16.78	7.18	10.44	7.95	8.20	33.64	33.50
	2	13.52	16.65	6.91	10.41	7.86	8.17	33.62	33.50
	3	13.44	16.61	6.14	10.11	7.82	8.17	33.65	33.50
	4	13.30	16.50	6.11	10.01	7.82	8.14	33.56	33.52
	5	13.26	16.38	5.99	9.64	7.83	8.11	33.54	33.51
	6	13.23	15.44	6.05	9.12	7.83	8.00	33.53	33.76
	7	13.19		5.98		7.81		33.54	
RW13	0	15.31	16.63	6.98	9.15	7.94	8.15	33.50	33.49
	1	15.26	16.60	6.89	9.28	7.94	8.14	33.49	33.50
	2	14.39	16.53	7.14	9.39	7.95	8.14	33.83	33.51
	3	14.14	16.24	6.96	9.44	7.85	8.13	33.59	33.55
	4	13.47	15.23	6.37	9.42	7.81	8.04	33.62	33.68
	5	13.37	14.31	5.87	8.53	7.81	7.93	33.56	33.62
	6	13.38	14.20	5.76	7.60	7.81	7.90	33.54	33.74
	7	13.42		5.71		7.79		33.53	
RW14	0	15.28	16.37	7.82	8.87	8.04	8.11	33.51	33.50
	1	15.22	16.34	7.82	8.95	8.04	8.11	33.51	33.50
	2	15.04	16.33	7.97	8.98	8.00	8.11	33.53	33.50
	3	14.76	16.32	7.69	8.99	7.98	8.11	33.55	33.50
	4	14.28	16.25	7.37	9.02	7.94	8.11	33.53	33.52
	5	13.95	15.78	6.91	9.04	7.89	8.08	33.56	33.56
	6	14.11	14.56	6.57	8.51	7.88	7.97	33.41	33.52
RW15	0	15.19	16.64	6.54	8.98	7.90	8.11	33.46	33.47
	1	14.83	16.66	6.66	8.92	7.90	8.11	33.56	33.48
	2	13.94	16.59	6.58	9.05	7.83	8.11	33.64	33.49
	3	13.69	16.50	5.79	9.03	7.78	8.11	33.57	33.49
	4	13.62	16.28	5.40	8.99	7.77	8.09	33.53	33.50
	5	13.60	16.11	5.38	8.91	7.76	8.09	33.52	33.50
	6	13.61	15.90	5.32	8.77	7.76	8.07	33.52	33.55
	7	13.62	15.55	5.23	8.67	7.75	8.03	33.52	33.55
	8	13.65	14.09	5.20	8.02	7.75	7.87	33.51	33.91

Appendix C-2. (Cont.).

	Depth (m)	Temp. (°C)		Oxygen (mg/l)		pH		Salinity (ppt)	
		FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW16	0	14.84	16.56	6.68	8.95	7.90	8.12	33.47	33.50
	1	14.80	16.54	6.73	9.07	7.90	8.12	33.50	33.50
	2	14.14	16.50	6.91	9.11	7.86	8.13	33.63	33.50
	3	13.46	16.45	6.70	9.15	7.79	8.13	33.60	33.53
	4	13.35	15.42	6.01	9.46	7.78	8.05	33.54	33.71
	5	13.37	14.57	5.82	8.83	7.77	7.95	33.53	33.61
	6	13.39	14.44	5.79	7.37	7.78	7.92	33.53	33.53
RW17	0	15.42	16.66	7.08	9.84	7.96	8.18	33.50	33.49
	1	15.33	16.65	7.14	9.85	7.96	8.19	33.53	33.49
	2	14.67	16.61	7.34	9.88	7.94	8.18	33.54	33.49
	3	14.05	16.56	7.05	9.84	7.88	8.17	33.64	33.50
	4	13.43	16.48	6.67	9.72	7.83	8.14	33.56	33.50
	5	13.28	15.28	6.16	9.76	7.81	8.07	33.57	33.73
	6	13.21	14.57	5.98	8.35	7.81	7.94	33.54	33.54

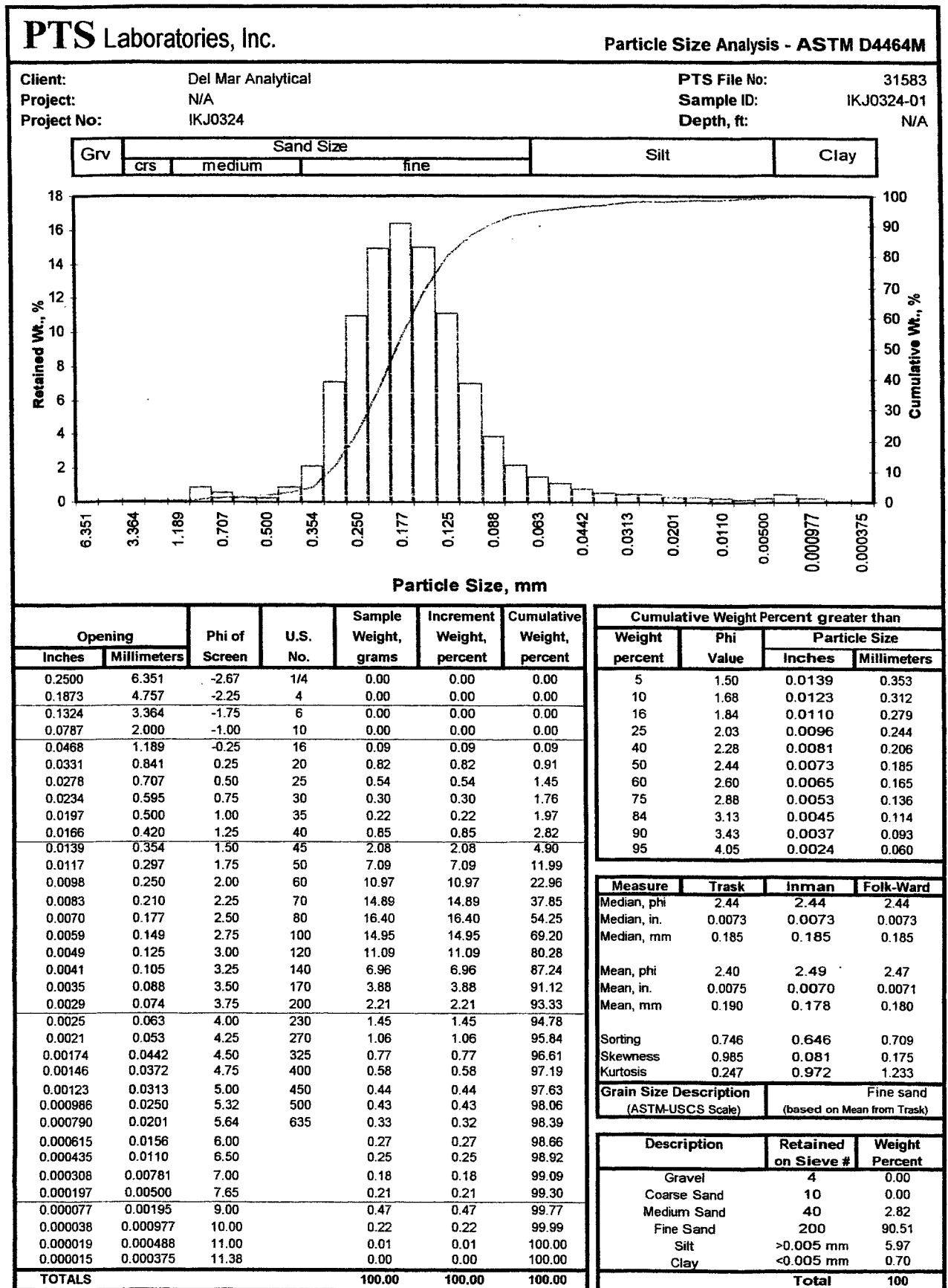
## **APPENDIX D**

### **Sediment grain size distribution and statistical parameters by station**

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Appendix D. Sediment grain size distribution and statistical parameters by station. Reliant Energy Mandalay generating station NPDES, 2001.

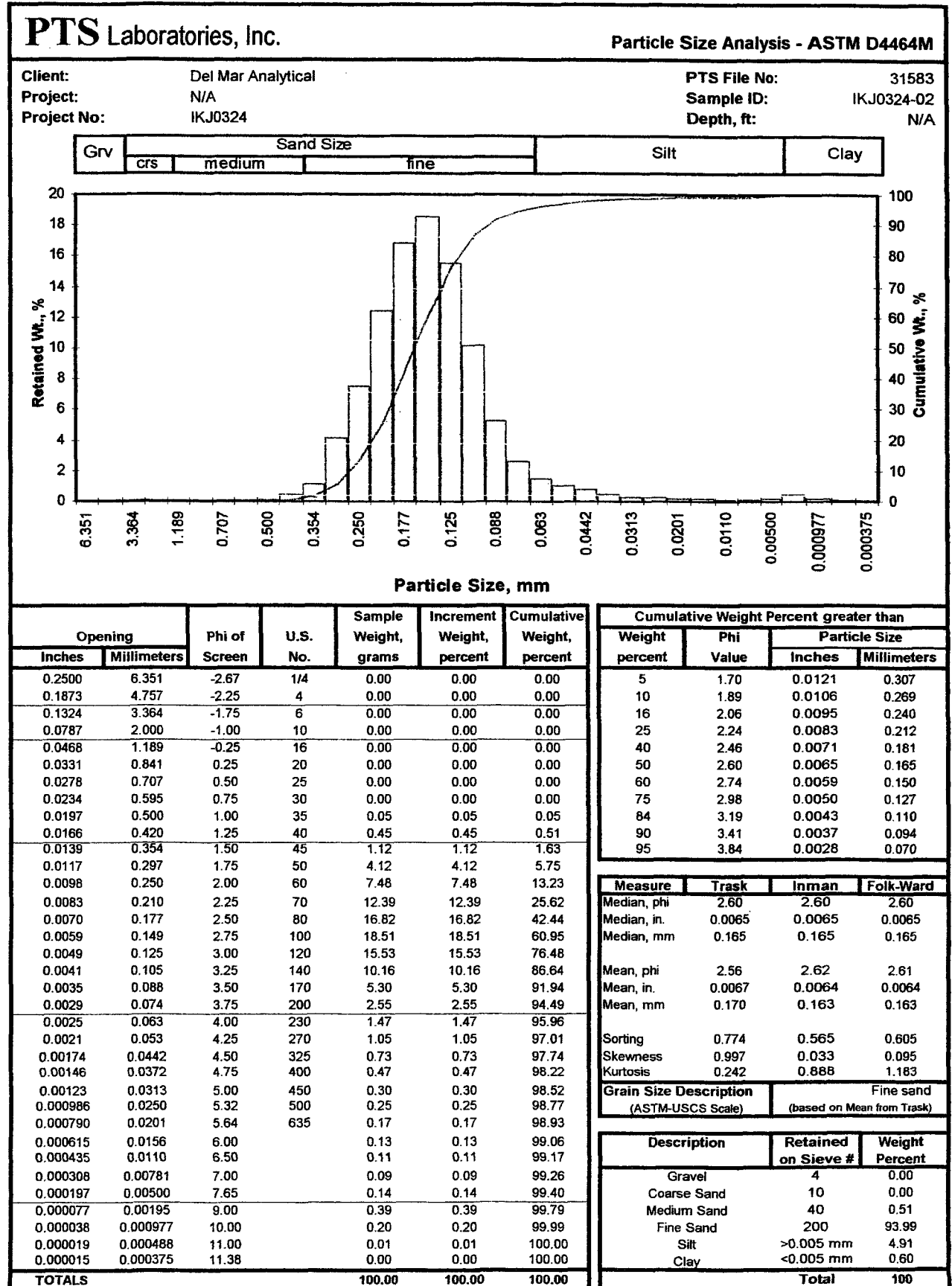
Station B1



012

## Appendix D. (Cont.).

Station B2



## Appendix D. (Cont.).

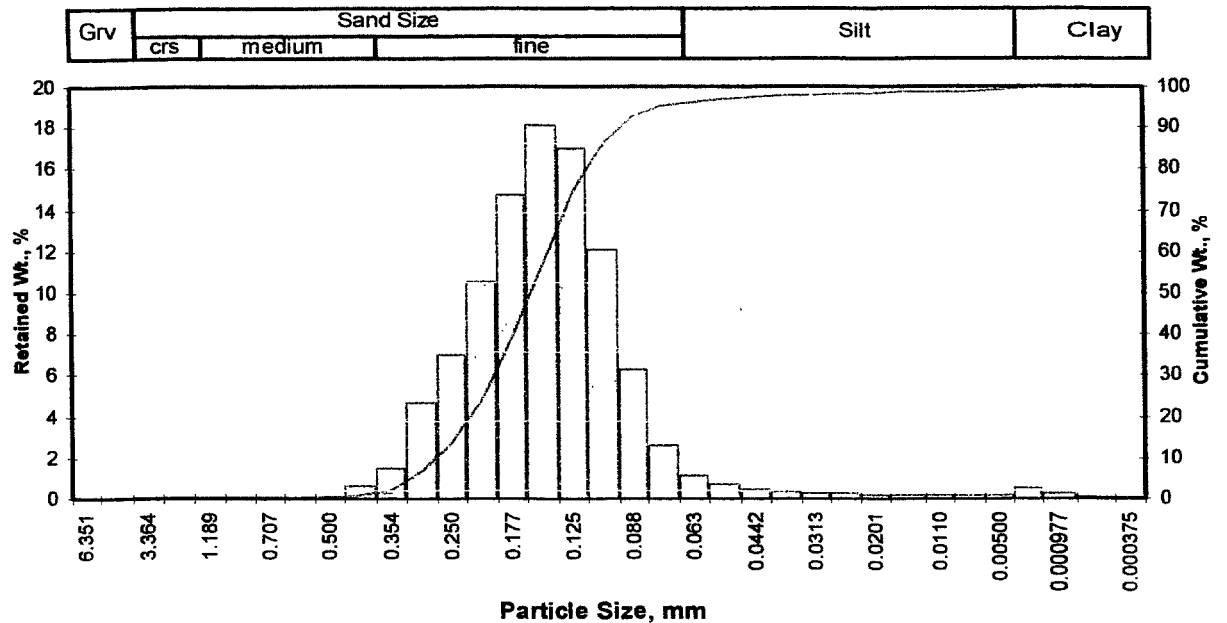
Station B3

**PTS** Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client: Del Mar Analytical  
 Project: N/A  
 Project No: IKJ0324

PTS File No: 31583  
 Sample ID: IKJ0324-03  
 Depth, ft: N/A



Opening		Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
Inches	Millimeters					
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.00	0.00	0.00
0.0331	0.841	0.25	20	0.00	0.00	0.00
0.0278	0.707	0.50	25	0.00	0.00	0.00
0.0234	0.595	0.75	30	0.00	0.00	0.00
0.0197	0.500	1.00	35	0.07	0.07	0.07
0.0166	0.420	1.25	40	0.64	0.64	0.71
0.0139	0.354	1.50	45	1.50	1.50	2.21
0.0117	0.297	1.75	50	4.66	4.66	6.87
0.0098	0.250	2.00	60	6.98	6.98	13.85
0.0083	0.210	2.25	70	10.53	10.53	24.38
0.0070	0.177	2.50	80	14.73	14.73	39.11
0.0059	0.149	2.75	100	18.08	18.08	57.19
0.0049	0.125	3.00	120	16.99	16.99	74.18
0.0041	0.105	3.25	140	12.05	12.05	86.23
0.0035	0.088	3.50	170	6.28	6.28	92.51
0.0029	0.074	3.75	200	2.58	2.58	95.09
0.0025	0.063	4.00	230	1.12	1.12	96.21
0.0021	0.053	4.25	270	0.69	0.69	96.89
0.00174	0.0442	4.50	325	0.46	0.46	97.36
0.00146	0.0372	4.75	400	0.31	0.31	97.67
0.00123	0.0313	5.00	450	0.23	0.23	97.90
0.000986	0.0250	5.32	500	0.24	0.24	98.14
0.000790	0.0201	5.64	635	0.21	0.21	98.35
0.000615	0.0156	6.00		0.19	0.19	98.54
0.000435	0.0110	6.50		0.20	0.20	98.74
0.000308	0.00781	7.00		0.16	0.16	98.90
0.000197	0.00500	7.65		0.21	0.21	99.11
0.000077	0.00195	9.00		0.49	0.49	99.61
0.000038	0.000977	10.00		0.30	0.30	99.91
0.000019	0.000488	11.00		0.09	0.09	100.00
0.000015	0.000375	11.38		0.00	0.00	100.00
TOTALS				100.00	100.00	100.00

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size	
		Inches	Millimeters
5	1.65	0.0125	0.319
10	1.86	0.0108	0.275
16	2.05	0.0095	0.241
25	2.26	0.0082	0.209
40	2.51	0.0069	0.175
50	2.65	0.0063	0.159
60	2.79	0.0057	0.144
75	3.02	0.0049	0.124
84	3.20	0.0043	0.109
90	3.40	0.0037	0.095
95	3.74	0.0029	0.075

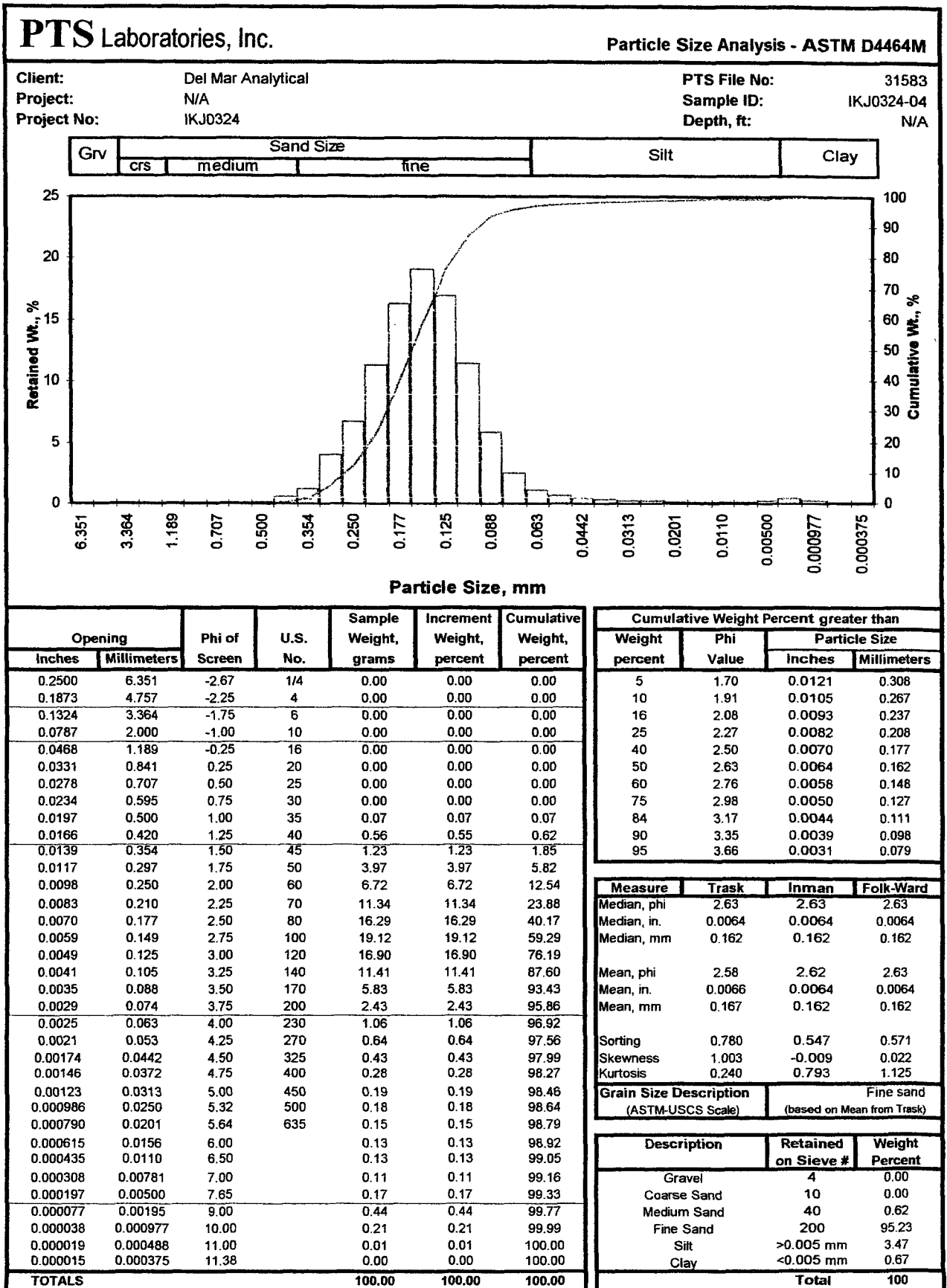
Measure	Trask	Inman	Folk-Ward
Median, phi	2.65	2.65	2.65
Median, in.	0.0063	0.0063	0.0063
Median, mm	0.159	0.159	0.159
Mean, phi	2.59	2.63	2.64
Mean, in.	0.0065	0.0064	0.0063
Mean, mm	0.166	0.162	0.161
Sorting	0.769	0.576	0.605
Skewness	1.008	-0.040	0.001
Kurtosis	0.236	0.815	1.133

Grain Size Description (ASTM-USCS Scale) Fine sand  
 (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.71
Fine Sand	200	94.37
Silt	>0.005 mm	4.03
Clay	<0.005 mm	0.89
Total		100

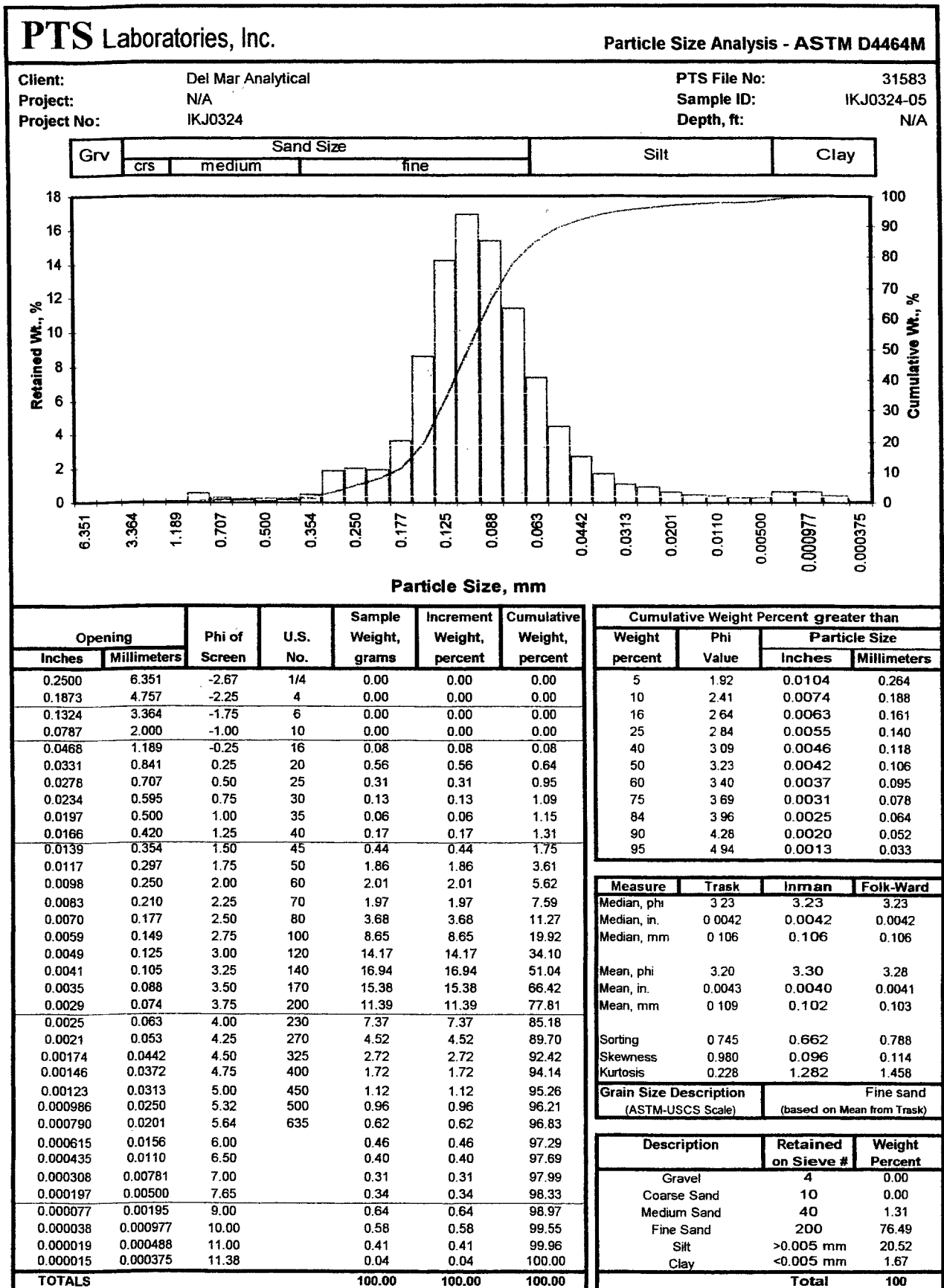
## Appendix D. (Cont.).

Station B4



## Appendix D. (Cont.).

Station B5



916

**Appendix D-1. Yearly grain size values, 1990 - 2001. Reliant Energy Mandalay generating station NPDES, 2001.**

Year	Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean grain size				
						phi	µm	Sorting	Skewness	Kurtosis
2001	B1	0.00	94.78	4.52	0.70	2.47	180	0.71	0.18	1.23
	B2	0.00	95.96	3.44	0.60	2.61	163	0.61	0.10	1.18
	B3	0.00	96.21	2.90	0.89	2.64	161	0.61	0.00	1.13
	B4	0.00	96.92	2.41	0.67	2.63	162	0.57	0.02	1.13
	B5	0.00	85.18	13.15	1.67	3.28	103	0.79	0.11	1.46
2000	B1	0.00	92.10	6.40	1.50	2.55	171	0.93	0.16	1.24
	B2	0.00	93.42	4.97	1.61	2.71	153	0.73	0.16	1.36
	B3	0.00	90.14	7.69	2.17	2.70	154	0.98	0.23	1.72
	B4	0.00	94.23	4.09	1.68	2.65	160	0.65	0.23	1.26
	B5	0.00	83.51	14.01	2.48	3.34	99	0.86	0.28	1.68
1999	B1	0.00	94.55	4.41	1.04	2.67	158	0.72	0.01	1.31
	B2	0.00	94.21	4.89	0.90	2.41	188	0.87	0.13	1.14
	B3	0.00	95.60	3.57	0.83	2.56	169	0.75	0.00	1.06
	B4	0.00	96.79	2.53	0.68	2.27	207	0.75	0.02	1.16
	B5	0.00	76.32	21.05	2.63	3.55	85	0.84	0.28	1.48
1998	B1	0.12	93.37	5.33	1.17	3.01	124	65.30	0.16	1.23
	B2	0.01	98.14	1.82	0.02	2.59	166	71.18	-0.12	1.09
	B3	0.25	92.88	5.70	1.17	2.89	135	58.93	0.10	1.14
	B4	-	-	-	-	-	-	-	-	-
	B5	-	-	-	-	-	-	-	-	-
1997	B1	2.14	85.05	10.34	2.47	3.31	101	60.14	0.10	1.30
	B2	1.82	93.66	3.06	1.45	2.79	145	61.12	-0.10	1.11
	B3	0.16	69.54	28.49	1.82	3.80	72	60.25	0.14	1.15
	B4	0.28	93.28	5.68	0.76	3.08	119	65.17	0.08	1.12
	B5	0.12	96.07	3.34	0.47	2.62	163	59.24	-0.03	0.98
1994	B1	0.00	6.89	91.74	1.37	3.05	121	65.76	-0.01	1.16
	B2	0.38	4.45	46.64	48.53	0.12	920	39.76	-0.37	0.50
	B3	1.15	33.34	65.31	0.20	3.93	66	61.17	0.25	1.17
	B4	0.00	5.40	89.57	5.04	2.61	164	55.63	-0.25	1.96
	B5	0.13	2.23	97.43	0.21	2.48	179	66.01	0.02	1.11
1993	B1	20.44	78.30	0.84	0.42	1.07	480	N.A.	N.A.	N.A.
	B2	0.23	98.66	0.74	0.37	2.47	180	N.A.	N.A.	N.A.
	B3	0.80	93.69	5.09	0.42	2.48	179	N.A.	N.A.	N.A.
	B4	0.59	98.95	0.00	0.46	2.23	213	N.A.	N.A.	N.A.
	B5	0.05	90.83	8.72	0.40	2.50	177	N.A.	N.A.	N.A.
1992	B1	1.37	97.68	0.71	0.24	2.45	183	N.A.	N.A.	N.A.
	B2	0.00	98.80	0.60	0.60	2.48	179	N.A.	N.A.	N.A.
	B3	5.05	93.59	0.91	0.45	2.37	193	N.A.	N.A.	N.A.
	B4	8.84	89.79	0.69	0.69	2.58	167	N.A.	N.A.	N.A.
	B5	0.54	91.55	7.01	0.90	2.57	168	N.A.	N.A.	N.A.
1991	B1	0.33	93.39	5.23	1.05	2.58	167	N.A.	N.A.	N.A.
	B2	0.24	95.14	3.60	1.03	2.42	186	N.A.	N.A.	N.A.
	B3	1.11	89.44	8.40	1.05	2.40	190	N.A.	N.A.	N.A.
	B4	0.20	95.54	3.20	1.07	2.38	192	N.A.	N.A.	N.A.
	B5	0.00	83.57	14.73	1.70	3.13	114	N.A.	N.A.	N.A.
1990	B1	1.84	96.28	1.88	0.00	2.35	196	68.62	-0.04	1.33
	B2	0.60	98.86	2.53	0.01	2.68	156	72.52	-0.07	1.48
	B3	1.11	95.87	3.01	0.01	2.54	173	74.10	-0.07	1.47
	B4	4.88	92.48	2.64	0.01	2.37	193	66.20	-0.31	2.95
	B5	0.15	90.52	9.33	0.00	3.38	96	76.64	0.11	1.34

N.A. = Not Available  
 - = not sampled

## APPENDIX E

Sediment chemistry by station

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Appendix E. Sediment chemistry by station. Reliant Energy Mandalay generating station NPDES, 2001.



Del Mar Analytical

2652 Alton Ave., Irvine, CA 92606 (949) 261-1022 FAX (949) 261-1228  
 1014 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (909) 370-1046  
 16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1813  
 9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (658) 505-9596 FAX (658) 505-9689  
 9830 South 51st St., Suite B 170, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851

MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MBC Applied Environmental Sciences  
 01204A/Reliant MGS  
 Report Number: IKH0005

Sampled: 07/25/01  
 Received: 08/01/01

**METALS**

Analyte	Method	Batch	Reporting Limit mg/kg dry	Sample Result mg/kg dry	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
<b>Sample ID: IKH0005-01 (B1 (I,II,III) - Solid)</b>								
Chromium	EPA 6010B	I1H0238	1.5	11	1	8/2/01	8/3/01	
Copper	EPA 6010B	I1H0238	1.5	2.5	1	8/2/01	8/3/01	
Nickel	EPA 6010B	I1H0238	1.5	6.7	1	8/2/01	8/3/01	
Zinc	EPA 6010B	I1H0238	7.5	21	1	8/2/01	8/3/01	
<b>Sample ID: IKH0005-02 (B2 (I,II,III) - Solid)</b>								
Chromium	EPA 6010B	I1H0238	1.4	8.9	1	8/2/01	8/3/01	
Copper	EPA 6010B	I1H0238	1.4	2.3	1	8/2/01	8/3/01	
Nickel	EPA 6010B	I1H0238	1.4	6.3	1	8/2/01	8/3/01	
Zinc	EPA 6010B	I1H0238	7.2	18	1	8/2/01	8/3/01	
<b>Sample ID: IKH0005-03 (B3 (I,II,III) - Solid)</b>								
Chromium	EPA 6010B	I1H0238	1.6	11	1	8/2/01	8/3/01	
Copper	EPA 6010B	I1H0238	1.6	2.6	1	8/2/01	8/3/01	
Nickel	EPA 6010B	I1H0238	1.6	6.7	1	8/2/01	8/3/01	
Zinc	EPA 6010B	I1H0238	8.1	20	1	8/2/01	8/3/01	
<b>Sample ID: IKH0005-04 (B4 (I,II,III) - Solid)</b>								
Chromium	EPA 6010B	I1H0238	1.8	13	1	8/2/01	8/3/01	
Copper	EPA 6010B	I1H0238	1.8	2.8	1	8/2/01	8/3/01	
Nickel	EPA 6010B	I1H0238	1.8	8.0	1	8/2/01	8/3/01	
Zinc	EPA 6010B	I1H0238	9.1	23	1	8/2/01	8/3/01	

Del Mar Analytical, Irvine  
 Xuan Huong Dang  
 Project Manager

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Appendix E. (Cont.).



Del Mar Analytical

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 1014 E. Coolidge Dr. Suite A, Colton, CA 92324 (909) 370 4667 FAX (909) 370-1041  
 16525 Sherman Way, Suite C 11, Van Nuys, CA 91406 (818) 779 1844 FAX (818) 779-1841  
 9484 Chesapeake Dr., Suite 905, San Diego, CA 92123 (619) 505 9556 FAX (619) 505-9689  
 9830 South 51st St., Suite B 120, Phoenix, AZ 85044 (480) 785 0043 FAX (480) 785 0865

MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MBC Applied Environmental Sciences  
 01204A/Reliant MGS  
 Report Number: IKH0005

Sampled: 07/25/01  
 Received: 08/01/01

**METALS**

Analyte	Method	Batch	Reporting Limit mg/kg dry	Sample Result mg/kg dry	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IKH0005-05 (B5 (I,II,III) - Solid)								
Chromium	EPA 6010B	11H0238	1.5	8.3	1	8/2/01	8/3/01	
Copper	EPA 6010B	11H0238	1.5	2.5	1	8/2/01	8/3/01	
Nickel	EPA 6010B	11H0238	1.5	6.0	1	8/2/01	8/3/01	
Zinc	EPA 6010B	11H0238	7.6	18	1	8/2/01	8/3/01	

Del Mar Analytical, Irvine  
 Xuan Huong Dang  
 Project Manager

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Appendix E. (Cont.).



Del Mar Analytical

1852 Alton Ave. Irvine, CA 92606 (949) 261-1022 FAX (949) 261-1228  
 1014 E. Conley Dr., Suite A, Cotton CA 92331 (909) 370-4667 FAX (909) 370-1016  
 18625 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843  
 9484 Chesapeake Dr. Suite 805, San Diego, CA 92123 (619) 505-9596 FAX (619) 505-9689  
 9830 South 51st St., Suite B 120 Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851

MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MBC Applied Environmental Sciences  
 01204A/Reliant MGS  
 Report Number: IKH0005

Sampled: 07/25/01  
 Received: 08/01/01

INORGANICS

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
			%	%				
Sample ID: IKH0005-01 (B1 (I,II,III) - Solid)								
Percent Solids	EPA 160.3	MOD11H0657	0.010	66	1	8/6/01	8/6/01	
Sample ID: IKH0005-02 (B2 (I,II,III) - Solid)								
Percent Solids	EPA 160.3	MOD11H0657	0.010	69	1	8/6/01	8/6/01	
Sample ID: IKH0005-03 (B3 (I,II,III) - Solid)								
Percent Solids	EPA 160.3	MOD11H0657	0.010	62	1	8/6/01	8/6/01	
Sample ID: IKH0005-04 (B4 (I,II,III) - Solid)								
Percent Solids	EPA 160.3	MOD11H0657	0.010	55	1	8/6/01	8/6/01	
Sample ID: IKH0005-05 (B5 (I,II,III) - Solid)								
Percent Solids	EPA 160.3	MOD11H0657	0.010	66	1	8/6/01	8/6/01	

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MBC Applied Env. Sciences  
3000 Redhill Avenue  
Costa Mesa, CA 92626-4524  
Attention: Mike Curtis

Project ID: MBC Applied Environmental Sciences  
01204A/Reliant MGS  
Report Number: IKH0005

Sampled: 07/25/01  
Received: 08/01/01

METHOD BLANK/QC DATA

METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC %REC	Limits RPD	RPD Limit	Data Qualifiers
<b>Batch: I1H0238 Extracted: 08/02/01</b>									
<b>Blank Analyzed: 08/03/01 (I1H0238-BLK1)</b>									
Chromium	ND	1.0	mg/kg wet						
Copper	ND	1.0	mg/kg wet						
Nickel	ND	1.0	mg/kg wet						
Zinc	ND	5.0	mg/kg wet						
<b>LCS Analyzed: 08/03/01 (I1H0238-BS1)</b>									
Chromium	44.9	1.0	mg/kg wet	50.0		90	80-120		
Copper	45.8	1.0	mg/kg wet	50.0		92	80-120		
Nickel	44.4	1.0	mg/kg wet	50.0		89	80-120		
Zinc	43.1	5.0	mg/kg wet	50.0		86	80-120		
<b>Matrix Spike Analyzed: 08/03/01 (I1H0238-MS1)</b>									
					<b>Source: IKH0045-01</b>				
Chromium	62.0	1.0	mg/kg wet	50.0	15	94	75-125		
Copper	59.8	1.0	mg/kg wet	50.0	17	86	75-125		
Nickel	60.0	1.0	mg/kg wet	50.0	11	98	75-125		
Zinc	202	5.0	mg/kg wet	50.0	63	278	75-125		MI
<b>Matrix Spike Dup Analyzed: 08/03/01 (I1H0238-MSD1)</b>									
					<b>Source: IKH0045-01</b>				
Chromium	62.4	1.0	mg/kg wet	50.0	15	95	75-125	1	20
Copper	59.2	1.0	mg/kg wet	50.0	17	84	75-125	1	20
Nickel	73.5	1.0	mg/kg wet	50.0	11	125	75-125	20	20 R
Zinc	219	5.0	mg/kg wet	50.0	63	312	75-125	8	20 MI

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MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MBC Applied Environmental Sciences  
 01204A/Reliant MGS  
 Report Number: IKH0005

Sampled: 07/25/01  
 Received: 08/01/01

METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC Limits	RPD	RPD Limit	Data Qualifiers
<b>Batch: 11H0657 Extracted: 08/06/01</b>									
<b>Blank Analyzed: 08/06/01 (11H0657-BLK1)</b>									
Percent Solids	ND	0.010	%						
<b>Duplicate Analyzed: 08/06/01 (11H0657-DUP1)</b>									
Percent Solids	65.6	0.010	%		66		1	20	

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MBC Applied Env. Sciences  
3000 Redhill Avenue  
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Attention: Mike Curtis

Project ID: MBC Applied Environmental Sciences  
01204A/Reliant MGS  
Report Number: IKH0005

Sampled: 07/25/01  
Received: 08/01/01

### DATA QUALIFIERS AND DEFINITIONS

- M1** The MS and/or MSD were above the acceptance limits due to sample matrix interference. See Blank Spike (LCS).  
**R** The RPD exceeded the method control limit due to sample matrix effects. The individual analyte QA/QC recoveries, however, were within acceptance limits.  
**ND** Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.  
**NR** Not reported.  
**RPD** Relative Percent Difference

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**Appendix E-1. Yearly sediment metal concentrations, 1990 - 2001. Reliant Energy Mandalay generating station NPDES, 2001.**

Metal	Station	Year										Mean
		1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	
Chromium ERL = 81	B1	9.7	25.3	7.2	8.9	9.6	8.8	7.0	11	11	11	11.0
	B2	15.6	37.2	7.8	7.4	9.6	8.7	7.2	7.5	10	8.9	12.0
	B3	8.7	23.4	10.1	9.3	12	11	7.2	9.1	9.9	11	11.2
	B4	9.3	14.3	10.0	8.1	12	9.2	-	7.9	9.6	13	10.4
	B5	11.3	24.6	8.8	8.4	8.4	9.2	-	13	13	8.3	11.7
Copper ERL = 34	B1	4.4	20.0	4.0	5.3	5.6	3.7	6.1	7.0	4.6	2.5	6.3
	B2	5.8	24.4	3.6	4.1	7.1	2.7	4.1	3.8	4.3	2.3	6.2
	B3	2.6	14.8	5.1	9.0	8.4	5.3	4.2	5.3	5.3	2.6	6.3
	B4	2.3	8.2	4.2	3.9	4.9	3.3	-	3.7	3.7	2.8	4.1
	B5	4.3	15.9	4.6	5.1	3.0	1.7	-	8.5	6.4	2.6	5.8
Nickel ERL = 21	B1	6.6	14.7	6.0	7.9	7.1	7.8	4.3	9.7	8.5	6.7	7.9
	B2	10.3	16.7	6.2	5.9	8.2	6.6	4.2	6.3	7.8	6.3	7.9
	B3	6.2	9.5	8.1	9.3	9.2	10	4.1	8.8	8.7	6.7	8.1
	B4	6.3	9.1	6.7	6.3	6.5	7.1	-	6.5	7.0	8.0	7.1
	B5	6.7	13.8	6.4	7.2	6.5	6.3	-	12.0	8.5	6.0	8.2
Zinc ERL = 150	B1	17	14.7	15.4	18	22	27	19	6.4	23	21	18.4
	B2	27	15.4	16.2	16	25	23	14	16	22	18	19.3
	B3	17	17.2	20.0	29	31	34	14	24	24	20	23.0
	B4	17	16.4	19.0	18	20	24	-	17	20	23	19.4
	B5	23	24.6	17.3	20	13	18	-	34	28	18	21.8
Fines	B1	1.9	6.3	1.0	1.3	6.9	12.8	6.5	5.5	7.9	5.2	5.5
	B2	2.5	4.6	1.2	1.1	4.8	4.5	1.8	5.8	6.6	4.0	3.7
	B3	3.0	9.5	1.4	5.5	34.5	30.3	6.9	4.4	9.9	3.8	10.9
	B4	2.7	4.3	1.4	0.5	5.4	6.4	-	3.2	5.8	3.1	3.6
	B5	9.3	16.4	7.9	9.1	2.4	3.8	-	23.7	16.5	14.8	11.6

ERL = Effects Range Low  
- = not sampled

## APPENDIX F

Mussel tissue chemistry by station

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Appendix F. Mussel chemistry by station. Reliant Energy Mandalay generating station NPDES, 2001.



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 2520 E. Sunset Rd., #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01  
 Received: 10/26/01

**METALS**

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
			mg/kg dry	mg/kg dry				
<b>Sample ID: IKJ1098-01 (MT-MN I - Solid)</b>								
Chromium	EPA 6010B	11J3081	5.5	ND	1	10/30/01	11/1/01	
Copper	EPA 6010B	11J3081	5.5	12	1	10/30/01	11/1/01	
Nickel	EPA 6010B	11J3081	5.5	ND	1	10/30/01	11/1/01	
Zinc	EPA 6010B	11J3081	28	130	1	10/30/01	11/1/01	
<b>Sample ID: IKJ1098-02 (MT-MN II - Solid)</b>								
Chromium	EPA 6010B	11J3081	6.3	ND	1	10/30/01	10/31/01	
Copper	EPA 6010B	11J3081	6.3	13	1	10/30/01	10/31/01	
Nickel	EPA 6010B	11J3081	6.3	ND	1	10/30/01	10/31/01	
Zinc	EPA 6010B	11J3081	32	260	1	10/30/01	10/31/01	
<b>Sample ID: IKJ1098-03 (MT-MN III - Solid)</b>								
Chromium	EPA 6010B	11J3081	5.9	ND	1	10/30/01	10/31/01	
Copper	EPA 6010B	11J3081	5.9	7.0	1	10/30/01	10/31/01	
Nickel	EPA 6010B	11J3081	5.9	ND	1	10/30/01	10/31/01	
Zinc	EPA 6010B	11J3081	30	140	1	10/30/01	10/31/01	
<b>Sample ID: IKJ1098-04 (MT-MNC I - Solid)</b>								
Chromium	EPA 6010B	11J3081	7.9	ND	1	10/30/01	10/31/01	
Copper	EPA 6010B	11J3081	7.9	13	1	10/30/01	10/31/01	
Nickel	EPA 6010B	11J3081	7.9	ND	1	10/30/01	10/31/01	
Zinc	EPA 6010B	11J3081	40	270	1	10/30/01	10/31/01	

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 Project Manager

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 9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (858) 505-8596 FAX (858) 505-966  
 9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-086  
 2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-366

MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

**METALS**

Analyte	Method	Batch	Reporting Limit mg/kg dry	Sample Result mg/kg dry	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
<b>Sample ID: IKJ1098-05 (MT-MNC II - Solid)</b>								
Chromium	EPA 6010B	11J3140	7.4	ND	1	10/31/01	11/2/01	
Copper	EPA 6010B	11J3140	7.4	16	1	10/31/01	11/2/01	
Nickel	EPA 6010B	11J3140	7.4	ND	1	10/31/01	11/2/01	
Zinc	EPA 6010B	11J3140	37	170	1	10/31/01	11/2/01	
<b>Sample ID: IKJ1098-06 (MT-MNC III - Solid)</b>								
Chromium	EPA 6010B	11J3140	9.5	ND	1	10/31/01	11/2/01	
Copper	EPA 6010B	11J3140	9.5	16	1	10/31/01	11/2/01	
Nickel	EPA 6010B	11J3140	9.5	ND	1	10/31/01	11/2/01	
Zinc	EPA 6010B	11J3140	47	250	1	10/31/01	11/2/01	

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MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

## INORGANICS

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
			%	%				
Sample ID: IKJ1098-01 (MT-MN I - Solid)								
Percent Solids	EPA 160.3 MOD IIJ2975		0.010	18	1	10/29/01	10/29/01	
Sample ID: IKJ1098-02 (MT-MN II - Solid)								
Percent Solids	EPA 160.3 MOD IIJ2975		0.010	16	1	10/29/01	10/29/01	
Sample ID: IKJ1098-03 (MT-MN III - Solid)								
Percent Solids	EPA 160.3 MOD IIJ2975		0.010	17	1	10/29/01	10/29/01	
Sample ID: IKJ1098-04 (MT-MNC I - Solid)								
Percent Solids	EPA 160.3 MOD IIJ2975		0.010	13	1	10/29/01	10/29/01	
Sample ID: IKJ1098-05 (MT-MNC II - Solid)								
Percent Solids	EPA 160.3 MOD IIJ2975		0.010	14	1	10/29/01	10/29/01	
Sample ID: IKJ1098-06 (MT-MNC III - Solid)								
Percent Solids	EPA 160.3 MOD IIJ2975		0.010	11	1	10/29/01	10/29/01	

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 Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

## METHOD BLANK/QC DATA

## METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC %REC	Limit	RPD RPD	Limit	Data Qualifiers
<b>Batch: 11J3081 Extracted: 10/30/01</b>										
<b>Blank Analyzed: 11/01/01 (11J3081-BLK1)</b>										
Chromium	ND	1.0	mg/kg wet							
Copper	ND	1.0	mg/kg wet							
Nickel	ND	1.0	mg/kg wet							
Zinc	ND	5.0	mg/kg wet							
<b>LCS Analyzed: 10/31/01 (11J3081-BS1)</b>										
Chromium	49.8	1.0	mg/kg wet	50.0		99.6	80-120			
Copper	46.3	1.0	mg/kg wet	50.0		92.6	80-120			
Nickel	48.2	1.0	mg/kg wet	50.0		96.4	80-120			
Zinc	48.2	5.0	mg/kg wet	50.0		96.4	80-120			
<b>Matrix Spike Analyzed: 10/31/01 (11J3081-MS1)</b>										
Chromium	55.3	1.0	mg/kg wet	50.0	9.1	92.4	75-125			
Copper	51.4	1.0	mg/kg wet	50.0	4.1	94.6	75-125			
Nickel	54.1	1.0	mg/kg wet	50.0	7.0	94.2	75-125			
Zinc	64.4	5.0	mg/kg wet	50.0	17	94.8	75-125			
<b>Matrix Spike Dup Analyzed: 10/31/01 (11J3081-MSD1)</b>										
Chromium	55.2	1.0	mg/kg wet	50.0	9.1	92.2	75-125	0.181	20	
Copper	50.6	1.0	mg/kg wet	50.0	4.1	93.0	75-125	1.57	20	
Nickel	52.7	1.0	mg/kg wet	50.0	7.0	91.4	75-125	2.62	20	
Zinc	63.5	5.0	mg/kg wet	50.0	17	93.0	75-125	1.41	20	

**Batch: 11J3140 Extracted: 10/31/01****Blank Analyzed: 11/02/01 (11J3140-BLK1)**

Chromium	ND	1.0	mg/kg wet							
Copper	ND	1.0	mg/kg wet							
Nickel	ND	1.0	mg/kg wet							
Zinc	ND	5.0	mg/kg wet							

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MBC Applied Env. Sciences  
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 Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

## METHOD BLANK/QC DATA

## METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC %REC Limits	RPD RPD	RPD Limit	Data Qualifiers
<b>Batch: I1J3140 Extracted: 10/31/01</b>									
<b>LCS Analyzed: 11/02/01 (I1J3140-BS1)</b>									
Chromium	51.8	1.0	mg/kg wet	50.0		104 80-120			
Copper	49.5	1.0	mg/kg wet	50.0		99.0 80-120			
Nickel	49.8	1.0	mg/kg wet	50.0		99.6 80-120			
Zinc	49.3	5.0	mg/kg wet	50.0		98.6 80-120			
<b>Matrix Spike Analyzed: 11/03/01 (I1J3140-MS1)</b>									
Chromium	56.3	1.0	mg/kg wet	50.0	18	76.6 75-125			
Copper	60.0	1.0	mg/kg wet	50.0	21	78.0 75-125			
Nickel	50.6	1.0	mg/kg wet	50.0	13	75.2 75-125			
Zinc	104	5.0	mg/kg wet	50.0	68	72.0 75-125			M2
<b>Matrix Spike Dup Analyzed: 11/03/01 (I1J3140-MSD1)</b>									
Chromium	54.9	1.0	mg/kg wet	50.0	18	73.8 75-125	2.52	20	M2
Copper	58.4	1.0	mg/kg wet	50.0	21	74.8 75-125	2.70	20	
Nickel	49.6	1.0	mg/kg wet	50.0	13	73.2 75-125	2.00	20	M2
Zinc	101	5.0	mg/kg wet	50.0	68	66.0 75-125	2.93	20	M2

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MBC Applied Env. Sciences  
 3000 Redhill Avenue  
 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01  
 Received: 10/26/01

METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC Limits	RPD	RPD Limit	Data Qualifiers
<b>Batch: 11J2975 Extracted: 10/29/01</b>									
<b>Blank Analyzed: 10/29/01 (11J2975-BLK1)</b>									
Percent Solids	ND	0.010	%						
<b>Duplicate Analyzed: 10/29/01 (11J2975-DUP1)</b>									
Percent Solids	12.4	0.010	%		12		3.28	20	

Source: IKJ0978-01

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Attention: Mike Curtis

Project ID: MGS NPDES 01204A

Report Number: IKJ1098

Sampled: 10/19/01  
Received: 10/26/01

### DATA QUALIFIERS AND DEFINITIONS

**M2** The MS and/or MSD were below the acceptance limits due to sample matrix interference. See Blank Spike (LCS).  
**ND** Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.  
**NR** Not reported.  
**RPD** Relative Percent Difference

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 Costa Mesa, CA 92626-4524  
 Attention: Mike Curtis

Project ID: 01204A Catalina NPDES

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

## METALS

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
			mg/kg dry	mg/kg dry				
<b>Sample ID: IKJ1098-04 (MT-MNC I - Solid)</b>								
Chromium	EPA 6010B	11J3081	7.9	ND	1	10/30/01	10/31/01	
Copper	EPA 6010B	11J3081	7.9	13	1	10/30/01	10/31/01	
Nickel	EPA 6010B	11J3081	7.9	ND	1	10/30/01	10/31/01	
Zinc	EPA 6010B	11J3081	40	270	1	10/30/01	10/31/01	
<b>Sample ID: IKJ1098-05 (MT-MNC II - Solid)</b>								
Chromium	EPA 6010B	11J3140	7.4	ND	1	10/31/01	11/2/01	
Copper	EPA 6010B	11J3140	7.4	16	1	10/31/01	11/2/01	
Nickel	EPA 6010B	11J3140	7.4	ND	1	10/31/01	11/2/01	
Zinc	EPA 6010B	11J3140	37	170	1	10/31/01	11/2/01	
<b>Sample ID: IKJ1098-06 (MT-MNC III - Solid)</b>								
Chromium	EPA 6010B	11J3140	9.5	ND	1	10/31/01	11/2/01	
Copper	EPA 6010B	11J3140	9.5	16	1	10/31/01	11/2/01	
Nickel	EPA 6010B	11J3140	9.5	ND	1	10/31/01	11/2/01	
Zinc	EPA 6010B	11J3140	47	250	1	10/31/01	11/2/01	

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 Attention: Mike Curtis

Project ID: 01204A Catalina NPDES

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

## INORGANICS

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
			%	%				
Sample ID: IKJ1098-04 (MT-MNC I - Solid)								
Percent Solids	EPA 160.3 MOD 11J2975		0.010	13	1	10/29/01	10/29/01	
Sample ID: IKJ1098-05 (MT-MNC II - Solid)								
Percent Solids	EPA 160.3 MOD 11J2975		0.010	14	1	10/29/01	10/29/01	
Sample ID: IKJ1098-06 (MT-MNC III - Solid)								
Percent Solids	EPA 160.3 MOD 11J2975		0.010	11	1	10/29/01	10/29/01	

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Project ID: 01204A Catalina NPDES

Report Number: IKJ1098

Sampled: 10/19/01

Received: 10/26/01

METHOD BLANK/QC DATA

METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC %REC	Limits RPD	RPD Limit	Data Qualifiers
<b>Batch: I1J3081 Extracted: 10/30/01</b>									
<b>Blank Analyzed: 11/01/01 (I1J3081-BLK1)</b>									
Chromium	ND	1.0	mg/kg wet						
Copper	ND	1.0	mg/kg wet						
Nickel	ND	1.0	mg/kg wet						
Zinc	ND	5.0	mg/kg wet						
<b>LCS Analyzed: 10/31/01 (I1J3081-BS1)</b>									
Chromium	49.8	1.0	mg/kg wet	50.0		100	80-120		
Copper	46.3	1.0	mg/kg wet	50.0		93	80-120		
Nickel	48.2	1.0	mg/kg wet	50.0		96	80-120		
Zinc	48.2	5.0	mg/kg wet	50.0		96	80-120		
<b>Matrix Spike Analyzed: 10/31/01 (I1J3081-MS1)</b>									
Chromium	55.3	1.0	mg/kg wet	50.0	9.1	92	75-125		
Copper	51.4	1.0	mg/kg wet	50.0	4.1	95	75-125		
Nickel	54.1	1.0	mg/kg wet	50.0	7.0	94	75-125		
Zinc	64.4	5.0	mg/kg wet	50.0	17	95	75-125		
<b>Matrix Spike Dup Analyzed: 10/31/01 (I1J3081-MSD1)</b>									
Chromium	55.2	1.0	mg/kg wet	50.0	9.1	92	75-125	0	20
Copper	50.6	1.0	mg/kg wet	50.0	4.1	93	75-125	2	20
Nickel	52.7	1.0	mg/kg wet	50.0	7.0	91	75-125	3	20
Zinc	63.5	5.0	mg/kg wet	50.0	17	93	75-125	1	20
<b>Batch: I1J3140 Extracted: 10/31/01</b>									
<b>Blank Analyzed: 11/02/01 (I1J3140-BLK1)</b>									
Chromium	ND	1.0	mg/kg wet						
Copper	ND	1.0	mg/kg wet						
Nickel	ND	1.0	mg/kg wet						
Zinc	ND	5.0	mg/kg wet						

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 Attention: Mike Curtis

Project ID: 01204A Catalina NPDES

Report Number: IKJ1098

Sampled: 10/19/01  
 Received: 10/26/01

## METHOD BLANK/QC DATA

## METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC %REC	Limits RPD	RPD Limit	Data Qualifiers
<b>Batch: 11J3140 Extracted: 10/31/01</b>									
<b>LCS Analyzed: 11/02/01 (11J3140-BS1)</b>									
Chromium	51.8	1.0	mg/kg wet	50.0		104	80-120		
Copper	49.5	1.0	mg/kg wet	50.0		99	80-120		
Nickel	49.8	1.0	mg/kg wet	50.0		100	80-120		
Zinc	49.3	5.0	mg/kg wet	50.0		99	80-120		
<b>Matrix Spike Analyzed: 11/03/01 (11J3140-MS1)</b>									
					<b>Source: IKJ1156-01</b>				
Chromium	56.3	1.0	mg/kg wet	50.0	18	77	75-125		
Copper	60.0	1.0	mg/kg wet	50.0	21	78	75-125		
Nickel	50.6	1.0	mg/kg wet	50.0	13	75	75-125		
Zinc	104	5.0	mg/kg wet	50.0	68	72	75-125		M2
<b>Matrix Spike Dup Analyzed: 11/03/01 (11J3140-MSD1)</b>									
					<b>Source: IKJ1156-01</b>				
Chromium	54.9	1.0	mg/kg wet	50.0	18	74	75-125	3	20 M2
Copper	58.4	1.0	mg/kg wet	50.0	21	75	75-125	3	20
Nickel	49.6	1.0	mg/kg wet	50.0	13	73	75-125	2	20 M2
Zinc	101	5.0	mg/kg wet	50.0	68	66	75-125	3	20 M2

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 Attention: Mike Curtis

Project ID: 01204A Catalina NPDES

Report Number: IKJ1098

Sampled: 10/19/01  
 Received: 10/26/01

METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC Limits	RPD	RPD Limit	Data Qualifiers
<b>Batch: 11J2975 Extracted: 10/29/01</b>									
<b>Blank Analyzed: 10/29/01 (11J2975-BLK1)</b>									
Percent Solids	ND	0.010	%						
<b>Duplicate Analyzed: 10/29/01 (11J2975-DUP1)</b>									
Percent Solids	12.4	0.010	%		12		3	20	

Source: IKJ0978-01RE1

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Attention: Mike Curtis

Project ID: 01204A Catalina NPDES

Report Number: IKJ1098

Sampled: 10/19/01  
Received: 10/26/01

### DATA QUALIFIERS AND DEFINITIONS

**M2** The MS and/or MSD were below the acceptance limits due to sample matrix interference. See Blank Spike (LCS).  
**ND** Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.  
**NR** Not reported.  
**RPD** Relative Percent Difference

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## **APPENDIX G**

**Infauna data by station**

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**Appendix G-1. Infaunal master species list. Reliant Energy Mandalay generating station NPDES, 2001.**

PHYLUM Subphylum or Class Species	PHYLUM Subphylum or Class Species
<b>CNIDARIA</b>	<b>ANNELIDA (Cont.).</b>
Anthozoa	Polychaeta
<i>Zoetus actius</i>	<i>Nephtys cornuta</i>
	<i>Onuphis eremita parva</i>
<b>NEMERTEA</b>	<i>Onuphis</i> sp
Anopla	<i>Owenia collaris</i> <sup>5</sup>
<i>Carinoma mutabilis</i>	<i>Polydora</i> sp
Lineidae	<i>Scoloplos armiger</i> Cmplx <sup>6</sup>
<i>Tubulanus polymorphus</i> <sup>1</sup>	<i>Sigalion spinosus</i> <sup>7</sup>
Enopla	<i>Spirochaetopterus costarum</i>
<i>Zygonemertes virescens</i>	<i>Spiophanes bombyx</i>
	<i>Spiophanes duplex</i> <sup>8</sup>
	<i>Sthenelais verruculosa</i>
<b>MOLLUSCA</b>	<b>ARTHROPODA</b>
Bivalvia	Cirripedia
<i>Cooperella subdiaphana</i>	<i>Balanus pacificus</i>
<i>Macoma indentata</i>	Malacostraca
<i>Mactromeris catilliformis</i>	<i>Americhelidium shoemakeri</i> <sup>9</sup>
<i>Modiolus neglectus</i>	<i>Anchicolurus occidentalis</i>
<i>Modiolus</i> sp	<i>Aoroides inermis</i> <sup>10</sup>
<i>Siliqua lucida</i>	<i>Campylaspis</i> sp C Myers & Benedict 1974
<i>Tellina bodegensis</i>	<i>Cancer antennarius</i>
<i>Tellina modesta</i>	<i>Cerapus tubularis</i> Cmplx
Gastropoda	<i>Diastylopsis tenuis</i>
<i>Acteocina</i> sp	<i>Eohaustorius barnardi</i> <sup>11</sup>
<i>Crepidula norrisiarum</i>	<i>Gibberosus myersi</i> <sup>12</sup>
Gastropoda	<i>Hartmanodes hartmanae</i> <sup>13</sup>
<i>Nassarius perpinguis</i>	<i>Ischyrocerus anguipes</i>
<i>Olivella baetica</i>	<i>Isocheles pilosus</i>
<i>Rictaxis punctocaelatus</i>	<i>Leptocuma forsmanni</i>
	Paguridea (glaucothoe)
	<i>Photis brevipes</i>
<b>ANNELIDA</b>	<i>Photis macinerneyi</i>
Polychaeta	<i>Rhepoxynius menziesi</i> <sup>14</sup>
<i>Ampharete labrops</i>	<i>Rhepoxynius</i> sp A SCAMIT 1987
<i>Apopronospio pygmaea</i>	<i>Uromunna ubiquita</i> <sup>15</sup>
<i>Aricidea (Acmira) catherinae</i> <sup>2</sup>	Ostracoda
<i>Armandia brevis</i> <sup>3</sup>	<i>Euphilomedes longiseta</i>
<i>Caraziella</i> sp A SCAMIT 1995	
<i>Chone</i> sp SD 1 Pt. Loma 1997	<b>ECHINODERMATA</b>
<i>Cirriiformia</i> sp	Echinoidea
<i>Cirriiformia spirabranchia</i>	<i>Dendraster excentricus</i>
<i>Dispio uncinata</i>	Ophiuroidea
<i>Eteone fauchaldi</i>	Amphiuridae
<i>Glycera macrobranchia</i> <sup>4</sup>	
<i>Glycinde armigera</i>	
<i>Goniada littorea</i>	<b>PHORONA</b>
<i>Hesionella mccullochae</i>	Uncertain
Lumbrineridae	Phoronida
<i>Magelona pitelkai</i>	
<i>Magelona sacculata</i>	<b>NEMATODA</b>
<i>Mediomastus acutus</i>	Uncertain
<i>Mediomastus</i> spp	Nematoda
<i>Nephtys caecoides</i>	

The following footnotes indicate names used in previous surveys:

- |   |   |
|---|---|
| 1 <i>Tubulanus pellucidus/polymorphus</i>             | 9 <i>Synchelidium shoemakeri</i>                              |
| 2 <i>Acesta catherinae</i> , <i>Acmira catherinae</i> | 10 <i>Aora inermis</i>  |
| 3 <i>Armandia bioculata</i>                           | 11 <i>Eohaustorius washingtonianus</i>                        |
| 4 <i>Glycera convoluta</i>                            | 12 <i>Megaluropus longimerus</i>                              |
| 5 <i>Owenia fusiformis</i>                            | 13 <i>Monoculodes hartmanae</i>                               |
| 6 <i>Scoloplos "armiger"</i> , <i>S. armiger</i>      | 14 <i>Paraphoxus epistomus</i> , <i>Rhepoxynius epistomus</i> |
| 7 <i>Thalenessa spinosa</i>                           | 15 <i>Munna ubiquita</i>                                      |
| 8 <i>Spiophanes missionensis</i>                      |   |

Appendix G-2. Infauna results by station. Reliant Energy Mandalay generating station NPDES, 2001.

Phylum Species	Station					Total	Percent
	B1	B2	B3	B4	B5		
AN <i>Apopriopiospio pygmaea</i>	186	337	2	9	35	569	49.01
AN <i>Mediomastus acutus</i>	3	1	3	-	96	103	8.87
AR <i>Americhelidium shoemakeri</i>	17	9	-	31	11	68	5.86
AR <i>Rhepoxynius menziesi</i>	27	3	4	23	10	67	5.77
EC <i>Dendraster excentricus</i>	2	2	1	23	13	41	3.53
NE <i>Carinoma mutabilis</i>	4	10	8	2	5	29	2.50
AN <i>Scoloplos armiger</i> Cmplx	4	4	3	9	-	20	1.72
MO <i>Tellina modesta</i>	3	4	-	2	11	20	1.72
MO <i>Siliqua lucida</i>	2	10	-	1	4	17	1.46
MO <i>Mactromeris catilliformis</i>	-	-	-	-	14	14	1.21
AR <i>Rhepoxynius</i> sp A SCAMIT 1987	-	1	-	-	11	12	1.03
AN <i>Carraziella</i> sp A SCAMIT 1995	-	-	-	-	11	11	0.95
AN <i>Nephtys caecoides</i>	-	-	5	3	1	9	0.78
AN <i>Magelona pitelkai</i>	1	-	1	6	-	8	0.69
AN <i>Chone</i> sp SD 1 Pt Loma 1997	1	-	-	-	6	7	0.60
AR <i>Diastylopsis tenuis</i>	5	2	-	-	-	7	0.60
AN <i>Dispio uncinata</i>	-	5	1	1	-	7	0.60
AR <i>Eohaustorius barnardi</i>	2	-	-	1	4	7	0.60
AN <i>Armandia brevis</i>	1	1	-	-	4	6	0.52
MO <i>Cooperella subdiaphana</i>	-	-	-	-	6	6	0.52
AR <i>Photis macinermeyi</i>	1	5	-	-	-	6	0.52
AN <i>Ampharete labrops</i>	2	-	-	-	3	5	0.43
AR <i>Aoroides inermis</i>	-	-	-	-	5	5	0.43
AR <i>Euphilomedes longiseta</i>	3	-	-	2	-	5	0.43
AR <i>Gibberosus myersi</i>	2	-	3	-	-	5	0.43
AN <i>Goniada littorea</i>	4	-	-	-	1	5	0.43
AN <i>Onuphis</i> sp	2	2	-	1	-	5	0.43
AN <i>Owenia collaris</i>	1	-	1	-	3	5	0.43
AN <i>Spiochaetopterus costarum</i>	-	5	-	-	-	5	0.43
NE <i>Zygonemertes virescens</i>	1	2	1	1	-	5	0.43
AR <i>Balanus pacificus</i>	-	-	-	-	4	4	0.34
AN <i>Glycera macrobranchia</i>	-	1	2	1	-	4	0.34
NE <i>Lineidae</i>	-	2	-	-	2	4	0.34
AN <i>Spiophanes bombyx</i>	-	2	-	1	1	4	0.34
CN <i>Zaolutus actius</i>	-	-	-	-	4	4	0.34
EC <i>Amphiuridae</i>	1	1	-	1	-	3	0.26
AN <i>Glycinde armigera</i>	-	-	-	-	3	3	0.26
AR <i>Photis brevipes</i>	-	-	-	-	3	3	0.26
AN <i>Polydora</i> sp	-	-	-	-	3	3	0.26
AR <i>Uromunna ubiquita</i>	-	-	-	-	3	3	0.26
AR <i>Leptocuma forsmanni</i>	-	1	1	-	-	2	0.17
AN <i>Lumbrineridae</i>	-	-	-	-	2	2	0.17
MO <i>Macoma indentata</i>	-	1	1	-	-	2	0.17
AN <i>Magelona sacculata</i>	-	2	-	-	-	2	0.17
AN <i>Mediomastus</i> spp	1	-	1	-	-	2	0.17
MO <i>Modiolus neglectus</i>	-	-	-	-	2	2	0.17
MO <i>Olivella baetica</i>	-	1	-	1	-	2	0.17
AN <i>Onuphis eremita parva</i>	-	1	1	-	-	2	0.17
PR <i>Phoronida</i>	-	-	-	-	2	2	0.17
AN <i>Sthenelais verruculosa</i>	-	1	-	-	1	2	0.17
MO <i>Tellina bodegensis</i>	1	-	-	1	-	2	0.17
NE <i>Tubulanus polymorphus</i>	-	-	-	-	2	2	0.17
MO <i>Acteocina</i> sp	1	-	-	-	-	1	0.09
AR <i>Anchicolurus occidentalis</i>	1	-	-	-	-	1	0.09
AN <i>Aricidea</i> (Acmira) catherinae	-	-	-	-	1	1	0.09
AR <i>Campylaspis</i> sp C Myers & Benedict 1974	1	-	-	-	-	1	0.09
AR <i>Cancer antennarius</i>	-	-	-	1	-	1	0.09
AR <i>Cerapus tubularis</i> Cmplx	-	-	-	-	1	1	0.09
AN <i>Cirriformia</i> sp	1	-	-	-	-	1	0.09
AN <i>Cirriformia spirabrancha</i>	-	-	-	-	1	1	0.09
MO <i>Crepidula norrisiarum</i>	-	-	-	-	1	1	0.09
AN <i>Eteone fauchaldi</i>	-	1	-	-	-	1	0.09
MO <i>Gastropoda</i>	1	-	-	-	-	1	0.09
AR <i>Hartmanodes hartmanae</i>	-	1	-	-	-	1	0.09
AN <i>Hesionella mccullochae</i>	-	1	-	-	-	1	0.09
AR <i>Ischyrocerus anguipes</i>	-	-	-	-	1	1	0.09
AR <i>Isocheles pilosus</i>	-	1	-	-	-	1	0.09
MO <i>Modiolus</i> sp	-	-	-	-	1	1	0.09
MO <i>Nassarius perpinguis</i>	-	1	-	-	-	1	0.09
NT <i>Nematoda</i>	-	-	-	1	-	1	0.09
AN <i>Nephtys cornuta</i>	1	-	-	-	-	1	0.09

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Appendix G-2. (Cont.).

Phylum Species		Station					Percent	
		B1	B2	B3	B4	B5	Total	Total
AR	Paguridae (glaucothoe)	-	1	-	-	-	1	0.09
MO	<i>Rictaxis punctocaelatus</i>	1	-	-	-	-	1	0.09
AN	<i>Sigalion spinosus</i>	-	-	-	-	1	1	0.09
AN	<i>Spiophanes duplex</i>	-	1	-	-	-	1	0.09
Number of individuals		284	423	39	122	293	1161	
Number of species		32	34	17	22	40	75	
Diversity (H')		1.59	1.14	2.56	2.28	2.77	2.39	

Appendix G-3. Infaunal data by station and replicate. Reliant Energy Mandalay generating station NPDES, 2001.

Station B1

Phylum	Species	Replicate				Total	Percent Composition	Density No./m <sup>2</sup>
		B1-I	B1-II	B1-III	B1-IV			
AN	<i>Apopriospio pygmaea</i>	64	50	33	39	186	65.49	465.0
AR	<i>Rhepoxynius menziesi</i>	16	-	8	3	27	9.51	67.5
AR	<i>Americhelidium shoemakeri</i>	3	1	10	3	17	5.99	42.5
AR	<i>Diastylopsis tenuis</i>	3	1	1	-	5	1.76	12.5
AN	<i>Goniada littorea</i>	-	1	2	1	4	1.41	10.0
AN	<i>Scoloplos armiger</i> Cmplx	-	4	-	-	4	1.41	10.0
NE	<i>Carinoma mutabilis</i>	1	2	-	1	4	1.41	10.0
AN	<i>Mediomastus acutus</i>	-	1	2	-	3	1.06	7.5
AR	<i>Euphilomedes longiseta</i>	2	1	-	-	3	1.06	7.5
MO	<i>Tellina modesta</i>	-	1	-	2	3	1.06	7.5
AN	<i>Ampharete labrops</i>	2	-	-	-	2	0.70	5.0
AN	<i>Onuphis</i> sp	1	1	-	-	2	0.70	5.0
AR	<i>Eohaustorius barnardi</i>	2	-	-	-	2	0.70	5.0
AR	<i>Gibberosus myersi</i>	-	-	1	1	2	0.70	5.0
EC	<i>Dendroaster excentricus</i>	-	-	2	-	2	0.70	5.0
MO	<i>Siliqua lucida</i>	-	1	-	1	2	0.70	5.0
AN	<i>Armandia brevis</i>	-	-	-	1	1	0.35	2.5
AN	<i>Chone</i> sp SD 1 Pt Loma 1997	-	-	-	1	1	0.35	2.5
AN	<i>Cirriformia</i> sp	1	-	-	-	1	0.35	2.5
AN	<i>Magelona pitelkai</i>	1	-	-	-	1	0.35	2.5
AN	<i>Mediomastus</i> spp	1	-	-	-	1	0.35	2.5
AN	<i>Nephtys cornuta</i>	-	-	-	1	1	0.35	2.5
AN	<i>Owenia collaris</i>	-	-	-	1	1	0.35	2.5
AR	<i>Anchicolurus occidentalis</i>	-	-	1	-	1	0.35	2.5
AR	<i>Campylaspis</i> sp C Myers & Benedict 1974	-	-	1	-	1	0.35	2.5
AR	<i>Photis macinermeyi</i>	-	-	-	1	1	0.35	2.5
EC	Amphiuridae	-	-	-	1	1	0.35	2.5
MO	<i>Acteocina</i> sp	1	-	-	-	1	0.35	2.5
MO	Gastropoda	-	1	-	-	1	0.35	2.5
MO	<i>Rictaxis punctocaelatus</i>	1	-	-	-	1	0.35	2.5
MO	<i>Tellina bodegensis</i>	1	-	-	-	1	0.35	2.5
NE	<i>Zygonemertes virescens</i>	-	-	-	1	1	0.35	2.5

Summary

Parameter	Replicate				Station Total	Replicate	
	B1-I	B1-II	B1-III	B1-IV		Mean	S.D.
Number of individuals	100	65	61	58	284	71.0	19.5
Number of species	15	12	10	15	32	13.0	2.4
Diversity (H')	1.39	1.06	1.50	1.46	1.59	1.35	0.20

# Appendix G-3. (Cont.).

## Station B2

Phylum Species	Replicate				Total	Percent Composition	Density No./m <sup>2</sup>
	B2-I	B2-II	B2-III	B2-IV			
AN <i>Apopriospio pygmaea</i>	87	53	110	87	337	79.67	842.5
MO <i>Siliqua lucida</i>	-	2	8	-	10	2.36	25.0
NE <i>Carinoma mutabilis</i>	2	1	5	2	10	2.36	25.0
AR <i>Americhelidium shoemakeri</i>	4	1	1	3	9	2.13	22.5
AN <i>Dispio uncinata</i>	3	2	-	-	5	1.18	12.5
AN <i>Spiochaetopterus costarum</i>	-	1	3	1	5	1.18	12.5
AR <i>Photis macinermeyi</i>	-	1	-	4	5	1.18	12.5
AN <i>Scoloplos armiger</i> Cmplx	-	2	2	-	4	0.95	10.0
MO <i>Tellina modesta</i>	-	1	2	1	4	0.95	10.0
AR <i>Rhepoxynius menziesi</i>	-	2	-	1	3	0.71	7.5
AN <i>Magelona sacculata</i>	-	-	1	1	2	0.47	5.0
AN <i>Onuphis</i> sp	2	-	-	-	2	0.47	5.0
AN <i>Spiophanes bombyx</i>	-	-	-	2	2	0.47	5.0
AR <i>Diastylopsis tenuis</i>	-	-	1	1	2	0.47	5.0
EC <i>Dendroaster excentricus</i>	-	1	-	1	2	0.47	5.0
NE Lineidae	-	1	1	-	2	0.47	5.0
NE <i>Zygonemertes virescens</i>	-	2	-	-	2	0.47	5.0
AN <i>Armandia brevis</i>	-	-	1	-	1	0.24	2.5
AN <i>Eteone fauchaldi</i>	-	1	-	-	1	0.24	2.5
AN <i>Glycera macrobranchia</i>	-	-	1	-	1	0.24	2.5
AN <i>Hesionella maculochae</i>	1	-	-	-	1	0.24	2.5
AN <i>Mediomastus acutus</i>	1	-	-	-	1	0.24	2.5
AN <i>Onuphis eremita parva</i>	1	-	-	-	1	0.24	2.5
AN <i>Spiophanes duplex</i>	-	-	1	-	1	0.24	2.5
AN <i>Sthenelais verruculosa</i>	-	1	-	-	1	0.24	2.5
AR <i>Hartmanodes hartmanae</i>	-	-	-	1	1	0.24	2.5
AR <i>Isocheles pilosus</i>	-	-	-	1	1	0.24	2.5
AR <i>Leptocuma forsmanni</i>	-	1	-	-	1	0.24	2.5
AR Paguridae (glaucothoe)	1	-	-	-	1	0.24	2.5
AR <i>Rhepoxynius</i> sp A SCAMIT 1987	-	-	-	1	1	0.24	2.5
EC Amphiuridae	-	-	1	-	1	0.24	2.5
MO <i>Macoma indentata</i>	-	-	-	1	1	0.24	2.5
MO <i>Nassarius perpinguis</i>	-	-	1	-	1	0.24	2.5
MO <i>Olivella baetica</i>	-	-	-	1	1	0.24	2.5

## Summary

Parameter	Replicate				Station Total	Replicate	
	B2-I	B2-II	B2-III	B2-IV		Mean	S.D.
Number of individuals	102	73	139	109	423	105.8	27.1
Number of species	9	16	15	16	34	14.0	3.4
Diversity (H')	0.70	1.31	0.99	1.02	1.14	1.01	0.25

Appendix G-3. (Cont.).

Station B3

Phylum	Species	Replicate				Total	Percent Composition	Density No./m <sup>2</sup>
		B3-I	B3-II	B3-III	B3-IV			
NE	<i>Carinoma mutabilis</i>	1	-	6	1	8	20.51	20.0
AN	<i>Nephtys caecoides</i>	-	3	2	-	5	12.82	12.5
AR	<i>Rhepoxynius menziesi</i>	1	2	-	1	4	10.26	10.0
AN	<i>Mediomastus acutus</i>	-	-	1	2	3	7.69	7.5
AN	<i>Scoloplos armiger</i> Cmplx	2	-	1	-	3	7.69	7.5
AR	<i>Gibberosus myersi</i>	2	-	1	-	3	7.69	7.5
AN	<i>Apopriospio pygmaea</i>	-	1	1	-	2	5.13	5.0
AN	<i>Glycera macrobranchia</i>	1	-	-	1	2	5.13	5.0
AN	<i>Dispio uncinata</i>	-	1	-	-	1	2.56	2.5
AN	<i>Magelona pitelkai</i>	-	-	1	-	1	2.56	2.5
AN	<i>Mediomastus</i> spp	1	-	-	-	1	2.56	2.5
AN	<i>Onuphis eremita parva</i>	-	-	1	-	1	2.56	2.5
AN	<i>Owenia collaris</i>	-	1	-	-	1	2.56	2.5
AR	<i>Leptocuma forsmanni</i>	-	-	1	-	1	2.56	2.5
EC	<i>Dendraster excentricus</i>	-	-	-	1	1	2.56	2.5
MO	<i>Macoma indentata</i>	1	-	-	-	1	2.56	2.5
NE	<i>Zygonemertes virescens</i>	1	-	-	-	1	2.56	2.5

Summary

Parameter	Replicate				Station Total	Replicate	
	B3-I	B3-II	B3-III	B3-IV		Mean	S.D.
Number of individuals	10	8	15	6	39	9.8	3.9
Number of species	8	5	9	5	17	6.8	2.1
Diversity (H')	2.03	1.49	1.90	1.56	2.56	1.74	0.26

Appendix G-3. (Cont.).

Station B4

Phylum Species	Replicate				Total	Percent Composition	Density No./m <sup>2</sup>
	B4-I	B4-II	B4-III	B4-IV			
AR <i>Americhelidium shoemakeri</i>	9	8	6	8	31	25.41	77.5
AR <i>Rhepoxynius menziesi</i>	2	2	3	16	23	18.85	57.5
EC <i>Dendraster excentricus</i>	6	7	7	3	23	18.85	57.5
AN <i>Apoprionospio pygmaea</i>	2	4	3	-	9	7.38	22.5
AN <i>Scoloplos armiger</i> Cmplx	3	4	-	2	9	7.38	22.5
AN <i>Magelona pitelkai</i>	2	1	1	2	6	4.92	15.0
AN <i>Nephtys caecoides</i>	-	3	-	-	3	2.46	7.5
AR <i>Euphilomedes longiseta</i>	1	-	1	-	2	1.64	5.0
MO <i>Tellina modesta</i>	-	1	-	1	2	1.64	5.0
NE <i>Carinoma mutabilis</i>	1	-	1	-	2	1.64	5.0
AN <i>Dispio uncinata</i>	-	1	-	-	1	0.82	2.5
AN <i>Glycera macrobranchia</i>	1	-	-	-	1	0.82	2.5
AN <i>Onuphis</i> sp	1	-	-	-	1	0.82	2.5
AN <i>Spiophanes bombyx</i>	-	-	1	-	1	0.82	2.5
AR <i>Cancer antennarius</i>	1	-	-	-	1	0.82	2.5
AR <i>Eohaustorius barnardi</i>	1	-	-	-	1	0.82	2.5
EC Amphiuridae	-	-	-	1	1	0.82	2.5
MO <i>Olivella baetica</i>	1	-	-	-	1	0.82	2.5
MO <i>Siliqua lucida</i>	1	-	-	-	1	0.82	2.5
MO <i>Tellina bodegensis</i>	-	1	-	-	1	0.82	2.5
NE <i>Zygonemertes virescens</i>	1	-	-	-	1	0.82	2.5
NT Nematoda	1	-	-	-	1	0.82	2.5

Summary

Parameter	Replicate				Station Total	Replicate	
	B4-I	B4-II	B4-III	B4-IV		Mean	S.D.
Number of individuals	34	32	23	33	122	30.5	5.1
Number of species	16	10	8	7	22	10.3	4.0
Diversity (H')	2.41	2.03	1.79	1.46	2.28	1.92	0.40

Appendix G-3. (Cont.).

Station B5

Phylum	Species	Replicate				Total	Percent Composition	Density No./m <sup>2</sup>
		B5-I	B5-II	B5-III	B5-IV			
AN	<i>Mediomastus acutus</i>	15	33	33	15	96	32.76	240.0
AN	<i>Apoprionospio pygmaea</i>	8	9	5	13	35	11.95	87.5
MO	<i>Mactromeris catilliformis</i>	8	1	2	3	14	4.78	35.0
EC	<i>Dendraster excentricus</i>	3	3	2	5	13	4.44	32.5
AN	<i>Carraziella</i> sp A SCAMIT 1995	-	10	1	-	11	3.75	27.5
AR	<i>Americhelidium shoemakeri</i>	5	2	1	3	11	3.75	27.5
AR	<i>Rhepoxynius</i> sp A SCAMIT 1987	-	-	2	9	11	3.75	27.5
MO	<i>Tellina modesta</i>	2	1	7	1	11	3.75	27.5
AR	<i>Rhepoxynius menziesi</i>	1	1	7	1	10	3.41	25.0
AN	<i>Chone</i> sp SD 1 Pt Loma 1997	2	-	2	2	6	2.05	15.0
MO	<i>Cooperella subdiaphana</i>	1	-	2	3	6	2.05	15.0
AR	<i>Aoroides inermis</i>	-	1	4	-	5	1.71	12.5
NE	<i>Carinoma mutabilis</i>	5	-	-	-	5	1.71	12.5
AN	<i>Armadia brevis</i>	-	-	3	1	4	1.37	10.0
AR	<i>Balanus pacificus</i>	-	-	4	-	4	1.37	10.0
AR	<i>Eohaustorius barnardi</i>	-	-	3	1	4	1.37	10.0
CN	<i>Zaolutus actius</i>	-	-	3	1	4	1.37	10.0
MO	<i>Siliqua lucida</i>	3	-	-	1	4	1.37	10.0
AN	<i>Ampharete labrops</i>	-	1	1	1	3	1.02	7.5
AN	<i>Glycinde armigera</i>	-	2	1	-	3	1.02	7.5
AN	<i>Owenia collaris</i>	3	-	-	-	3	1.02	7.5
AN	<i>Polydora</i> sp	-	1	2	-	3	1.02	7.5
AR	<i>Photis brevipes</i>	1	1	1	-	3	1.02	7.5
AR	<i>Uromunna ubiquita</i>	-	2	1	-	3	1.02	7.5
AN	Lumbrineridae	-	-	2	-	2	0.68	5.0
MO	<i>Modiolus neglectus</i>	-	1	1	-	2	0.68	5.0
NE	Lineidae	-	-	1	1	2	0.68	5.0
NE	<i>Tubulanus polymorphus</i>	1	-	1	-	2	0.68	5.0
PR	Phoronida	1	-	1	-	2	0.68	5.0
AN	<i>Aricidea (Acmira) catherinae</i>	-	-	1	-	1	0.34	2.5
AN	<i>Cirriformia spirabrancha</i>	-	-	-	1	1	0.34	2.5
AN	<i>Goniada littorea</i>	-	-	-	1	1	0.34	2.5
AN	<i>Nephtys caecoides</i>	1	-	-	-	1	0.34	2.5
AN	<i>Sigalion spinosus</i>	-	-	1	-	1	0.34	2.5
AN	<i>Spiophanes bombyx</i>	-	-	1	-	1	0.34	2.5
AN	<i>Sthenelais verruculosa</i>	-	-	-	1	1	0.34	2.5
AR	<i>Cerapus tubularis</i> Cmplx	-	1	-	-	1	0.34	2.5
AR	<i>Ischyrocerus anguipes</i>	-	1	-	-	1	0.34	2.5
MO	<i>Crepdula norrisiarum</i>	-	1	-	-	1	0.34	2.5
MO	<i>Modiolus</i> sp	-	-	1	-	1	0.34	2.5

Summary

Parameter	Replicate				Station Total	Replicate	
	B5-I	B5-II	B5-III	B5-IV		Mean	S.D.
Number of individuals	60	72	97	64	293	73.3	16.6
Number of species	16	18	30	19	40	20.8	6.3
Diversity (H')	2.38	1.98	2.71	2.39	2.77	2.36	0.30

**Appendix G-4. Infaunal wet weight biomass data (g). Reliant Energy Mandalay generating station NPDES, 2001.**

Sta-Rep	Annelida	Arthropoda	Mollusca	Echinodermata	Misc.	Total
B1-I	0.284	0.105	0.094	-	0.061	0.544
B1-II	0.021	0.079	0.003	-	0.044	0.147
B1-III	0.013	0.006	-	13.833 <sup>1</sup>	-	13.852
B1-IV	0.025	0.022	0.020	0.005	0.022	0.094
Total	0.343	0.212	0.117	13.838	0.127	14.637
B2-I	0.175	0.007	-	-	0.052	0.234
B2-II	0.721	0.007	0.005	0.070	0.005	0.808
B2-III	0.107	0.024	0.032	0.001	0.004	0.168
B2-IV	0.072	0.001	0.227	4.804 <sup>2</sup>	0.003	5.107
Total	1.075	0.039	0.264	4.875	0.064	6.317
B3-I	0.100	0.028	0.064	-	0.055	0.247
B3-II	0.010	0.001	-	-	-	0.011
B3-III	0.433	0.048	-	-	0.006	0.487
B3-IV	0.012	0.021	-	0.050	0.003	0.086
Total	0.555	0.098	0.064	0.050	0.064	0.831
B4-I	0.144	0.168	0.071	20.172 <sup>3</sup>	0.067	20.622
B4-II	0.012	0.002	0.014	42.252 <sup>4</sup>	-	42.280
B4-III	0.003	0.025	-	34.687 <sup>5</sup>	0.008	34.723
B4-IV	0.095	0.013	0.008	19.050 <sup>6</sup>	-	19.166
Total	0.254	0.208	0.093	116.161	0.075	116.791
B5-I	0.094	0.031	0.042	19.200 <sup>7</sup>	0.066	19.433
B5-II	0.010	0.004	0.459	16.659 <sup>8</sup>	-	17.132
B5-III	0.037	0.071	3.105 <sup>9</sup>	11.071 <sup>10</sup>	1.898	16.182
B5-IV	0.063	0.024	0.049	24.517 <sup>11</sup>	0.626	25.279
Total	0.204	0.130	3.655	71.447	2.590	78.026
Grand Total	2.431	0.687	4.193	206.371	2.920	216.602

Note: - = no animals

Note: 1 = two large *Dendraster excentricus*, 2 = one large *Dendraster excentricus*, 3 = six large *Dendraster excentricus*, 4 = seven large *Dendraster excentricus*, 5 = seven large *Dendraster excentricus*, 6 = three large *Dendraster excentricus*, 7 = three large *Dendraster excentricus*, 8 = three large *Dendraster excentricus*, 9 = one *Modiolus neglectus*, 10 = two large *Dendraster excentricus*, 11 = five large *Dendraster excentricus*.

Appendix G-5. Yearly infaunal abundance, 1978 - 2001. Reliant Energy Mandalay generating station NPDES, 2001.

Species	Year														Total	Percent
	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001		
<i>Donax gouldii</i>	-	-	-	-	-	-	-	-	-	-	3064	-	2	-	3066	18.15
<i>Apopriospio pygmaea</i>	86	213	17	175	52	490	170	128	203	100	658	28	143	569	3032	17.94
<i>Mediomastus acutus</i>	5	1	-	-	-	-	-	1	58	35	1026	28	12	103	1269	7.51
<i>Scoloplos armiger</i> Cmplx	61	28	20	111	187	149	55	69	43	71	16	10	10	20	850	5.03
<i>Rhepoxynius menziesi</i>	17	25	20	61	43	14	18	14	34	-	35	270	84	67	702	4.15
<i>Diastylopsis tenuis</i>	123	163	75	33	12	9	5	11	88	45	2	51	56	7	680	4.02
<i>Spiophanes bombyx</i>	14	51	92	46	17	2	3	154	60	15	13	8	43	4	522	3.09
<i>Dendroaster excentricus</i>	12	1	43	17	87	14	14	-	10	103	52	75	34	41	503	2.98
<i>Owenia collaris</i>	5	40	-	2	10	88	9	44	2	130	8	31	111	5	485	2.87
<i>Euphilomedes carcharodonta</i>	-	1	1	3	-	-	-	-	47	333	-	-	-	-	385	2.28
<i>Siliqua lucida</i>	-	17	9	112	-	4	-	-	82	62	22	31	6	17	362	2.14
<i>Carinoma mutabilis</i>	-	3	16	18	7	18	28	19	25	24	78	17	18	29	300	1.78
<i>Magelona pitelkai</i>	9	131	-	38	13	21	14	24	20	5	-	1	-	8	284	1.68
<i>Tellina modesta</i>	2	18	29	2	4	-	-	1	11	101	2	19	46	20	255	1.51
<i>Goniada littorea</i>	21	26	6	-	6	2	-	3	6	11	36	74	37	5	233	1.38
<i>Pectinaria californiensis</i>	-	1	9	60	3	-	-	-	4	112	-	1	6	-	196	1.16
<i>Mediomastus spp</i>	-	9	16	17	12	7	4	-	-	-	91	2	1	2	161	0.95
<i>Zaolutus actius</i>	-	4	-	-	-	-	-	-	-	99	4	7	40	4	158	0.94
<i>Rhepoxynius sp A SCAMIT 1987</i>	2	5	9	12	26	11	-	-	23	37	-	4	11	12	152	0.90
<i>Nephtys caecoides</i>	6	4	8	5	9	24	8	11	14	3	3	6	11	9	121	0.72
<i>Americhelidium shoemakeri</i>	4	-	-	1	7	-	-	-	8	3	-	5	23	68	119	0.70
<i>Magelona sacculata</i>	2	23	47	22	16	4	-	-	-	-	-	-	-	2	116	0.69
<i>Photis macinermeyi</i>	-	-	13	45	-	-	-	-	4	20	2	5	10	6	105	0.62
<i>Chone albocincta</i>	-	-	-	-	5	14	-	5	9	62	-	-	-	-	95	0.56
<i>Solen sicarius</i>	2	-	9	16	3	5	2	5	3	20	20	3	6	-	94	0.56
<i>Isocheles pilosus</i>	12	1	-	75	1	-	-	-	-	1	-	-	2	1	93	0.55
<i>Mandibulophoxus gilesi</i>	14	-	-	-	-	36	15	-	4	15	-	-	3	-	87	0.51
<i>Onuphis eremita</i>	-	-	-	-	11	9	-	45	1	1	17	-	1	-	85	0.50
<i>Dispio uncinata</i>	9	20	10	6	2	-	-	-	1	4	-	4	9	7	72	0.43
<i>Eohaustorius barnardi</i>	17	12	9	4	1	-	-	-	5	11	1	1	4	7	72	0.43
Lineidae	-	-	-	1	-	-	-	-	-	9	22	13	5	4	54	0.32
<i>Spiochaetopterus costarum</i>	-	1	1	5	7	2	-	12	7	4	-	-	10	5	54	0.32
<i>Nemertea</i>	3	4	3	4	4	1	-	10	2	4	16	-	1	-	52	0.31
<i>Edotia sublittoralis</i>	1	7	-	1	-	-	-	-	1	35	1	-	2	-	48	0.28
<i>Photis sp</i>	17	30	-	-	-	-	-	-	-	-	-	-	-	-	47	0.28
<i>Spiophanes duplex</i>	4	17	-	11	-	-	-	4	3	1	1	-	5	1	47	0.28
Calanoida	6	39	-	-	-	-	-	-	-	-	-	-	-	-	45	0.27
<i>Euphilomedes longiseta</i>	-	-	-	2	10	22	-	-	-	-	3	-	3	5	45	0.27
<i>Glycera macrobranchia</i>	1	1	-	1	13	3	4	3	3	6	4	1	1	4	45	0.27
<i>Armandia brevis</i>	-	7	-	5	-	1	-	-	7	3	6	9	-	6	44	0.26
<i>Uromunna ubiquita</i>	-	-	-	1	-	-	-	-	-	33	2	4	1	3	44	0.26
<i>Macoma nasuta</i>	-	-	8	-	35	-	-	-	-	-	-	-	-	-	43	0.25
<i>Chone sp SD 1 Pt. Loma 1997</i>	-	-	-	-	-	-	-	-	-	-	14	1	20	7	42	0.25
<i>Ampharete labrops</i>	1	-	3	5	-	4	-	-	6	-	5	3	6	5	38	0.22
<i>Jassa slatteryi</i>	-	-	-	-	-	-	-	-	-	-	-	38	-	-	38	0.22
<i>Anchiculus occidentalis</i>	-	-	-	2	-	3	-	1	2	4	-	19	4	1	36	0.21
<i>Amastigos acutus</i>	-	35	-	-	-	-	-	-	-	-	-	-	-	-	35	0.21
<i>Paranemertes californica</i>	-	4	1	6	2	-	-	-	4	11	1	1	3	-	33	0.20
<i>Amatea occidentalis</i>	1	-	-	-	-	-	1	-	-	-	28	1	-	-	31	0.18
<i>Leptocuma forsmanni</i>	1	-	-	-	-	-	14	3	1	5	1	2	2	2	31	0.18
<i>Onuphis sp</i>	-	-	-	-	-	-	-	-	-	11	-	-	15	5	31	0.18
<i>Aricidea (Acmira) catherinae</i>	-	7	9	1	5	2	-	-	3	2	-	-	-	1	30	0.18
<i>Cooperella subdiaphana</i>	-	1	1	6	-	-	-	-	-	7	2	3	2	6	28	0.17
<i>Mysella pedroana</i>	-	1	-	27	-	-	-	-	-	-	-	-	-	-	28	0.17
<i>Neosabellaria cementarium</i>	-	-	-	-	-	-	-	-	-	-	-	27	-	-	27	0.16
<i>Gibberosus myersi</i>	2	-	1	1	-	-	-	-	2	8	-	3	4	5	26	0.15
<i>Polydora limicola</i>	-	-	-	-	-	-	-	-	26	-	-	-	-	-	26	0.15
<i>Tellina bodegensis</i>	-	-	1	2	2	-	-	-	13	1	-	3	1	2	25	0.15
<i>Campylaspis sp C Myers &amp; Benedict 1974</i>	-	-	-	-	-	-	-	1	1	1	-	8	12	1	24	0.14
Phorona	-	2	-	-	1	1	-	2	3	7	1	-	5	2	24	0.14
<i>Polydora sp</i>	1	1	1	14	1	2	-	1	-	-	-	-	-	3	24	0.14
Phoxocephalidae	-	-	-	-	-	16	7	-	-	-	-	-	-	-	23	0.14
<i>Syllis spp</i>	-	-	-	3	13	5	1	1	-	-	-	-	-	-	23	0.14
<i>Photis macrotica</i>	13	9	-	-	-	-	-	-	-	-	-	-	-	-	22	0.13
<i>Anoropallene palpida</i>	-	-	-	-	-	-	-	-	-	17	-	3	-	-	20	0.12
Mactridae	1	5	14	-	-	-	-	-	-	-	-	-	-	-	20	0.12
<i>Notomastus tenuis</i>	-	-	-	1	-	-	-	-	2	-	10	6	1	-	20	0.12
<i>Hemilamprops californica</i>	-	-	-	-	-	-	-	-	-	17	-	2	-	-	19	0.11
<i>Lepidopa californica</i>	2	1	5	3	-	-	4	3	-	-	-	1	-	-	19	0.11
<i>Prionospio lighti</i>	1	1	1	-	4	-	-	-	5	7	-	-	-	-	19	0.11
<i>Macoma sp</i>	-	-	6	-	-	-	-	1	2	-	-	2	7	-	18	0.11

## Appendix G-5. (Cont.).

Species	Year															Total	Percent
	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001			
<i>Polydora cornuta</i>	-	-	16	-	-	-	-	-	-	-	-	-	-	-	16	0.09	
<i>Sthenelais verruculosa</i>	-	1	2	-	-	1	1	2	-	-	2	-	5	2	16	0.09	
<i>Mactrotoma californica</i>	-	-	-	-	-	-	-	-	-	-	1	1	13	-	15	0.09	
<i>Stylochopiana</i> sp	-	-	-	3	2	-	-	-	-	7	2	-	1	-	15	0.09	
Amphiuridae	-	-	-	-	2	-	-	-	6	-	-	3	-	3	14	0.08	
<i>Chaetozone setosa</i> Cmplx	-	-	-	-	13	-	-	-	-	-	1	-	-	-	14	0.08	
<i>Mactromeris catilliformis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	14	14	0.08	
<i>Rhepoxynius</i> sp	10	-	-	-	-	-	4	-	-	-	-	-	-	-	14	0.08	
<i>Crepidula naticarum</i>	-	4	9	-	-	-	-	-	-	-	-	-	-	-	13	0.08	
<i>Cyclaspis nubila</i>	-	-	-	-	-	-	-	-	5	7	-	-	1	-	13	0.08	
<i>Balanus pacificus</i>	-	4	2	-	-	-	-	-	-	-	-	2	-	4	12	0.07	
<i>Cyclostremella dalli</i>	-	-	-	-	-	-	-	-	-	12	-	-	-	-	12	0.07	
<i>Eohaustorius sawyeri</i>	-	-	-	-	8	-	-	-	-	-	-	4	-	-	12	0.07	
<i>Onuphis iridescens</i>	-	5	-	7	-	-	-	-	-	-	-	-	-	-	12	0.07	
<i>Spisula catilliformis</i>	-	-	-	-	-	-	-	-	-	12	-	-	-	-	12	0.07	
<i>Sthenelais tertiaglabra</i>	-	-	-	-	-	-	-	-	2	6	-	4	-	-	12	0.07	
Actiniaria	-	-	-	-	6	-	-	-	5	-	-	-	-	-	11	0.07	
<i>Carraziella</i> sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	-	-	-	11	11	0.07	
<i>Cirriformia spirabrancha</i>	-	-	2	-	-	-	-	-	1	5	-	2	-	1	11	0.07	
<i>Dipolydora socialis</i>	-	-	-	-	-	-	-	-	11	-	-	-	-	-	11	0.07	
<i>Hesionella mccullochae</i>	-	-	-	-	-	-	-	-	-	1	3	1	5	1	11	0.07	
<i>Mysella</i> sp A SCAMIT 1988	-	-	-	-	-	-	-	-	-	11	-	-	-	-	11	0.07	
Nematoda	-	-	-	-	1	-	1	-	2	4	-	2	-	1	11	0.07	
<i>Neotrypaea</i> sp	1	1	7	1	-	-	-	1	-	-	-	-	-	-	11	0.07	
<i>Nephtys cornuta</i>	-	8	-	-	-	-	-	-	-	-	2	-	-	1	11	0.07	
<i>Phoronis</i> sp	-	3	-	8	-	-	-	-	-	-	-	-	-	-	11	0.07	
<i>Rictaxis punctocaelatus</i>	-	-	4	-	-	-	-	-	-	-	2	-	4	1	11	0.07	
<i>Scolecopsis squamata</i>	-	-	-	-	-	4	-	6	-	1	-	-	-	-	11	0.07	
Anthozoa	-	2	2	1	-	3	-	2	-	-	-	-	-	-	10	0.06	
<i>Ogyrides</i> sp A Roney 1978	1	-	3	1	-	-	-	-	1	1	-	2	1	-	10	0.06	
<i>Tubulanus polymorphus</i>	-	-	2	-	-	-	-	-	4	-	1	-	1	2	10	0.06	
<i>Mooreonuphis stigmatis</i>	-	-	-	-	-	-	-	-	-	-	-	9	-	-	9	0.05	
<i>Olivella baetica</i>	1	1	1	2	-	-	-	-	-	-	1	1	-	2	9	0.05	
<i>Sigalion spinosus</i>	-	-	2	2	-	1	-	-	3	-	-	-	-	1	9	0.05	
<i>Spiophanes berkeleyorum</i>	2	-	-	7	-	-	-	-	-	-	-	-	-	-	9	0.05	
<i>Tetrastemma</i> sp	-	-	-	-	-	-	-	-	3	4	-	2	-	-	9	0.05	
<i>Aoroides inermis</i>	-	-	-	-	-	-	-	-	-	-	-	3	-	5	8	0.05	
<i>Aoroides</i> sp	-	-	-	-	-	-	-	-	4	-	1	1	2	-	8	0.05	
<i>Aricidea</i> ( <i>Aedicira</i> ) <i>pacifica</i>	-	-	-	1	-	-	-	-	-	-	7	-	-	-	8	0.05	
<i>Glycinde polygnatha</i>	-	8	-	-	-	-	-	-	-	-	-	-	-	-	8	0.05	
<i>Leptosynapta</i> sp	-	1	1	2	-	1	-	3	-	-	-	-	-	-	8	0.05	
<i>Limnactiniidae</i> sp A SCAMIT 1989	-	-	-	-	5	-	-	-	-	1	1	1	-	-	8	0.05	
<i>Macoma secta</i>	-	2	-	1	-	3	-	-	-	1	-	-	1	-	8	0.05	
Onuphidae	1	-	-	-	1	-	1	-	1	1	-	-	3	-	8	0.05	
<i>Cerebratulus californiensis</i>	-	2	-	1	1	1	2	-	-	-	-	-	-	-	7	0.04	
<i>Glycinde amigera</i>	3	1	-	-	-	-	-	-	-	-	-	-	-	3	7	0.04	
<i>Macoma indentata</i>	-	-	-	-	-	-	-	-	3	2	-	-	-	2	7	0.04	
<i>Phyllodoce hartmanae</i>	-	-	3	3	1	-	-	-	-	-	-	-	-	-	7	0.04	
<i>Syllis</i> ( <i>Typosyllis</i> ) <i>farallonensis</i>	-	-	1	-	-	-	-	-	6	-	-	-	-	-	7	0.04	
<i>Amphiodia urtica</i>	-	-	-	-	1	1	3	1	-	-	-	-	-	-	6	0.04	
<i>Eohaustorius sencillus</i>	-	-	-	-	-	5	1	-	-	-	-	-	-	-	6	0.04	
<i>Lumbrineris californiensis</i>	-	-	1	-	-	-	-	-	1	-	-	2	2	-	6	0.04	
<i>Magelona californica</i>	-	-	-	-	-	-	-	-	-	-	-	-	6	-	6	0.04	
<i>Pollicipes polymerus</i>	-	-	6	-	-	-	-	-	-	-	-	-	-	-	6	0.04	
<i>Blepharipoda occidentalis</i>	-	-	-	-	-	-	2	2	1	-	-	-	-	-	5	0.03	
<i>Cumella californica</i>	-	1	-	-	1	-	-	-	-	3	-	-	-	-	5	0.03	
<i>Cyclaspis</i> sp C SCAMIT 1986	-	-	-	-	-	5	-	-	-	-	-	-	-	-	5	0.03	
<i>Heteromastus</i> sp	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5	0.03	
<i>Lamprops carinatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	5	-	5	0.03	
<i>Metamysidopsis elongata</i>	1	-	1	-	2	-	-	-	1	-	-	-	-	-	5	0.03	
<i>Nassarius perpinguis</i>	-	1	-	-	-	-	-	-	1	2	-	-	-	1	5	0.03	
<i>Nephtys</i> sp	-	-	-	-	1	1	1	-	-	-	-	-	-	-	5	0.03	
<i>Pseudoceros</i> sp	-	-	-	-	-	-	-	-	1	2	1	-	1	-	5	0.03	
<i>Spiophanes</i> sp	-	1	-	-	-	-	1	3	-	-	-	-	-	-	5	0.03	
<i>Syllis</i> ( <i>Typosyllis</i> ) sp	-	-	-	-	-	-	-	-	-	5	-	-	-	-	5	0.03	
<i>Zygonemertes virescens</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	0.03	
<i>Amphiodia</i> sp	-	-	-	-	-	-	-	-	-	3	-	1	-	-	4	0.02	
<i>Balanus</i> sp	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4	0.02	
<i>Cancer gracilis</i>	-	2	1	-	-	-	-	-	-	-	-	1	-	-	4	0.02	
<i>Chione</i> sp	-	-	4	-	-	-	-	-	-	-	-	-	-	-	4	0.02	
Gammaridea	1	1	-	-	-	-	1	-	-	-	-	-	1	-	4	0.02	

## Appendix G-5. (Cont.).

Species	Year															Total	Percent
	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001			
<i>Harpacticoida</i>	-	-	-	-	-	-	-	-	-	-	3	-	1	-	4	0.02	
<i>Hartmanodes hartmanae</i>	-	-	1	-	1	-	1	-	-	-	-	-	-	1	4	0.02	
<i>Macoma yoldiformis</i>	-	-	4	-	-	-	-	-	-	-	-	-	-	-	4	0.02	
<i>Modiolus neglectus</i>	-	2	-	-	-	-	-	-	-	-	-	-	-	2	4	0.02	
Mysidacea	1	2	-	-	-	1	-	-	-	-	-	-	-	-	4	0.02	
Phyllodocidae	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	0.02	
<i>Podarkeopsis glabra</i>	-	-	-	1	1	2	-	-	-	-	-	-	-	-	4	0.02	
<i>Rhepoxynius abronius</i>	-	-	-	-	-	-	-	-	1	-	-	-	3	-	4	0.02	
<i>Rocheffortia</i> sp A SCAMIT 1988	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4	0.02	
<i>Scolotoma tetraura</i> Cmplx	-	-	-	-	1	-	-	-	2	1	-	-	-	-	4	0.02	
<i>Tetrastemma</i> sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	3	1	-	-	4	0.02	
<i>Typosyllis aciculata</i>	1	3	-	-	-	-	-	-	-	-	-	-	-	-	4	0.02	
<i>Yoldia seminuda</i>	-	-	4	-	-	-	-	-	-	-	-	-	-	-	4	0.02	
<i>Anaitides</i> sp	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Anaitides williamsi</i>	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Anoplodactylus oculospinus</i>	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Carinomella lactea</i>	-	1	-	-	2	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Chone</i> sp	1	-	1	1	-	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Diopatra ornata</i>	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	0.02	
<i>Enopla</i> sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3	0.02	
Enteropneusta	1	-	-	-	-	-	-	-	-	1	-	1	-	-	3	0.02	
<i>Ischyrocerus anguipes</i>	-	-	-	-	-	-	-	-	-	-	-	2	-	1	3	0.02	
<i>Ischyrocerus pelagops</i>	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	0.02	
Lumbrineridae	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	0.02	
<i>Modiolus</i> sp	-	-	-	-	-	-	-	-	-	-	1	-	1	1	3	0.02	
<i>Monostyliifera</i> sp C SCAMIT 1995	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3	0.02	
<i>Neverita reclusiana</i>	-	-	-	1	1	-	-	-	-	1	-	-	-	-	3	0.02	
<i>Nuculana taphria</i>	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Odostomia</i> sp D MBC 1975	-	-	1	1	-	-	-	-	-	1	-	-	-	-	3	0.02	
<i>Onuphis eremita parva</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	0.02	
<i>Photis brevipes</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.02	
Platyhelminthes	1	-	-	1	1	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Polycirrus</i> sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3	0.02	
<i>Renilla kollikeri</i>	-	-	1	1	-	-	-	-	-	-	-	1	-	-	3	0.02	
<i>Sabellaria nanella</i>	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	0.02	
<i>Syllides</i> sp	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	0.02	
<i>Cancer</i> sp	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2	0.01	
<i>Cerapus tubularis</i> Cmplx	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.01	
<i>Crepidula</i> sp	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Eteone cf. alba</i>	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Eteone fauchaldi</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.01	
Gastropoda	-	-	-	-	-	-	-	-	-	-	-	1	-	1	2	0.01	
<i>Glycera nana</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Goniada maculata</i>	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	
<i>Heteropodarke heteromorpha</i>	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	0.01	
Holothuroidea	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2	0.01	
<i>Lumbrineris</i> sp	-	-	1	-	1	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Magelona</i> sp	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Micrura alaskensis</i>	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Nassarius fossatus</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.01	
Ophiuroidea	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	0.01	
Paguridae	-	-	-	-	-	1	-	-	-	-	-	-	-	1	2	0.01	
<i>Parasterope baresi</i>	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	0.01	
Pelecypoda	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2	0.01	
<i>Pholides asperus</i>	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	0.01	
Phoronopsis	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	0.01	
<i>Phyllochaetopterus prolifica</i>	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	0.01	
<i>Phyllodoce pettiboneae</i>	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	0.01	
<i>Pinnixa franciscana</i>	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Pinnixa</i> sp	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Polygireulima rutila</i>	-	-	-	-	1	-	-	-	1	-	-	-	-	-	2	0.01	
<i>Rhepoxynius stenodes</i>	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Rhepoxynius variatus</i>	-	-	-	-	1	-	-	-	-	-	-	1	-	-	2	0.01	
<i>Rocheffortia tumida</i>	-	-	-	-	-	-	-	-	-	1	-	1	-	-	2	0.01	
Spionidae	-	1	-	-	-	-	-	1	-	-	-	-	-	-	2	0.01	
<i>Synchelidium</i> sp	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Tenonia priops</i>	-	1	-	-	-	-	-	-	-	1	-	-	-	-	2	0.01	
<i>Zeuxo normani</i>	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.01	
<i>Acteocina</i> sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.01	
<i>Alienacanthomysis macropsis</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Amphideutopus oculatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	

## Appendix G-5. (Cont.).

Species	Year															Total	Percent
	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001			
<i>Amphiodia digitata</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.01	
<i>Amphiura acrystata</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Aricidea</i> sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	
<i>Axiiothella rubrocincta</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Cancer antennarius</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.01	
Capitellidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01	
<i>Caprella californica</i>	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01	
<i>Caprella</i> sp	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01	
<i>Caprella verrucosa</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Caudina arenicola</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Cerebratulus</i> sp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Cheatozone</i> sp	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01	
<i>Chone</i> sp C Harris 1984	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Cirriformia moorei</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.01	
<i>Cirriformia</i> sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.01	
<i>Crepidula norrisiarum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.01	
<i>Crepidula onyx</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
Crustacea (zoea)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01	
<i>Cryptoarachnidium argillum</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
Cumacea	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.01	
<i>Cyclaspis</i> sp B SCAMIT 1989	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Cyprideis stewarti</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	
<i>Ennucula tenuis</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
Entoprocta	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Eochelidium</i> sp A SCAMIT 1996	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.01	
<i>Eteone brigittae</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Exogone lourei</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	
<i>Foxiphalus obtusidens</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Gitanopsis vilordes</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Glycera</i> sp	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Harmothoe hirsuta</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	
<i>Hydractinia</i> sp	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
Ischyroceridae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.01	
<i>Kurtziella plumbea</i>	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Lamprops quadriplicata</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Leitoscoloplos pugettensis</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Leptopecten latiauratus</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.01	
<i>Malmgreniella</i> sp	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Monocorophium acherusicum</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	
<i>Monocorophium</i> sp	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.01	
<i>Monoculodes hartmanae</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Munnogonium tillerae</i>	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01	
<i>Rochefortia compressa</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Mysella</i> sp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Mysidopsis intii</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
Mytilidae	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Nereis procera</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Nitidiscala sawinae</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Odostomia</i> sp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Onuphis</i> sp	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Opisthopus transversus</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Pachycheilus rudis</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Parandalia ocularis</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.01	
<i>Paraonella platybranchia</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Paraprionospio pinnata</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.01	
<i>Parasterope hulingsi</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Pholoe glabra</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Photis</i> sp A SCAMIT 1995	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.01	
<i>Phylo felix</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Pista disjuncta</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Platyhelminthes</i> sp A of MBC	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Polydora cirrosa</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Postasterope barnesi</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
<i>Protothaca staminea</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	
Pycnogonida	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Pyromaia tuberculata</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
<i>Rhepoxynius lucubrans</i>	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.01	
Sigalionidae	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.01	
Sipuncula	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.01	
<i>Sphaerephesia similisetis</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.01	
<i>Stylochus exiguus</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.01	

Appendix G-5. (Cont.).

Species	Year															Percent	
	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	Total	Total	
<i>Sulcoretusa xystrum</i>	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Timarete luxuriosa</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.01	
<i>Tiron biocellata</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.01	
<i>Triticella elongata</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01	
Number of individuals	511	1049	612	1041	699	1021	399	599	946	1737	5311	896	915	1161	16897	100	
Number of species	54	79	68	72	70	53	35	38	81	92	59	82	79	75	288		
Number of stations / reps	5/1	5/1	5/1	5/4	5/4	5/4	5/4	5/4	5/4	5/4	3/4	5/4	5/4	5/4			
Diversity (H')	2.85	3.05	3.38	3.13	3.03	2.15	2.28	2.46	3.21	3.30	1.46	3.01	3.32	2.39	3.39		

NOTE: From 1978 to 1988 infaunal samples were collected in summer and winter. In this appendix, only summer samples are considered.

## APPENDIX H

Fish and macroinvertebrate trawl data by station

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**Appendix H-1. Master species list of fish and macroinvertebrate species taken by otter trawl. Reliant Energy Mandalay generating station NPDES, 2001.**

PHYLUM	Class	Family	Species	Common Name	PHYLUM	Class	Family	Species	Common Name
<b>ARTHROPODA</b>					<b>CHORDATA</b>				
	Malacostraca					Elasmobranchiomorphi (=Chondrichthys, Elasmobranchii)			
	Cancridae					Squalidae			
			<i>Cancer anthonyi</i>	yellow crab			<i>Squalus acanthias</i>		spiny dogfish
			<i>Cancer gracilis</i>	graceful rock crab		Rhinobatidae			
	Crangonidae						<i>Platyrrhinoidis triseriata</i>		thornback
			<i>Crangon nigromaculata</i>	blackspotted bay shrimp		Squatinae			
	Cymothoidae						<i>Squatina californica</i>		angel shark
			<i>Lironeca vulgaris</i>	fish louse		Myliobatidae			
	Hippolytidae						<i>Myliobatis californica</i>		bat ray
			<i>Heptacarpus palpator</i>	Intertidal coastal shrimp		Osteichthyes (=Actinopterygii)			
	Majidae					Clupeidae			
			<i>Pyromaia tuberculata</i>	tuberculate pear crab			<i>Sardinops sargax</i>		Pacific sardine
	Paniluridae					Engraulidae			
			<i>Panulirus interruptus</i>	California spiny lobster			<i>Engraulis mordax</i>		northern anchovy
	Portunidae					Synodontidae			
			<i>Portunus xantusii</i>	Xantus swimming crab			<i>Synodus lucioceps</i>		California lizardfish
						Batrachoididae			
							<i>Porichthys notatus</i>		plainfin midshipman
						Gasterosteidae			
							<i>Aulorhynchus flavidus</i>		tube-snout
						Syngnathidae			
							<i>Syngnathus californiensis</i>		kelp pipefish
						Sciaenidae			
							<i>Genyonemus lineatus</i>		white croaker
							<i>Menticirrhus undulatus</i>		California corbina
							<i>Seriophus politus</i>		queenfish
							<i>Umbrina roncadore</i>		yellowfin croaker
						Embiotocidae			
							<i>Amphistichus argenteus</i>		barred surfperch
							<i>Cymatogaster aggregata</i>		shiner perch
							<i>Hyperprosopon argenteum</i>		walleye surfperch
							<i>Phanerodon furcatus</i>		white seaperch
						Stromateidae			
							<i>Peprius similimus</i>		Pacific butterfish
						Bothidae			
							<i>Citharichthys stigmaeus</i>		speckled sanddab
							<i>Paralichthys californicus</i>		California halibut
							<i>Xystreurys liolepis</i>		fantail sole
						Pleuronectidae			
							<i>Pleuronichthys ritteri</i>		spotted turbot
							<i>Pleuronichthys verticalis</i>		hornyhead turbot
<b>MOLLUSCA</b>									
	Gastropoda								
	Nassariidae								
			<i>Nassarius perpinguis</i>	fat western nassa					
	Calliostomatidae								
			<i>Calliostoma sp</i>	topsnail					
<b>CNIDARIA</b>									
	Anthozoa								
	Renillidae								
			<i>Renilla kollikeri</i>	sea pansy					
<b>ECHINODERMATA</b>									
	Echinoidea								
	Dendrasteridae								
			<i>Dendraster excentricus</i>	Pacific sand dollar					
	Holothuroidea								
			<i>Caudina arenicola</i>	sweet potato					

Appendix H-2. Abundance of fish species in trawl replicates. Reliant Energy Mandalay generating station NPDES, winter 2001.

Species	Station-Replicate								Percent			
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	Total	Total	Mean	S.D.
<i>Genyonemus lineatus</i>	320	165	139	107	3	-	148	24	906	46.82	113.3	107.1
<i>Seriphus politus</i>	450	45	103	109	6	2	45	22	782	40.41	97.8	147.9
<i>Engraulis mordax</i>	66	6	16	20	2	21	5	9	145	7.49	18.1	20.6
<i>Citharichthys stigmaeus</i>	-	2	10	2	1	1	5	9	30	1.55	3.8	3.8
<i>Syngnathus californiensis</i>	7	7	2	1	1	-	4	3	25	1.29	3.1	2.7
<i>Menticirrhus undulatus</i>	1	2	8	2	-	-	8	2	23	1.19	2.9	3.3
<i>Amphistichus argenteus</i>	-	1	-	1	2	1	1	1	7	0.36	0.9	0.6
<i>Synodus lucioceps</i>	-	-	-	-	1	1	1	2	5	0.26	0.6	0.7
<i>Myliobatis californica</i>	1	1	1	1	-	-	-	-	4	0.21	0.5	0.5
<i>Platyrrhinoidis triseriata</i>	1	-	1	-	-	-	-	1	3	0.16	0.4	0.5
<i>Umbra roncadore</i>	-	-	3	-	-	-	-	-	3	0.16	0.4	1.1
<i>Cymatogaster aggregata</i>	-	-	-	-	-	-	1	-	1	0.05	0.1	0.4
<i>Paralichthys californicus</i>	-	-	-	-	-	-	-	1	1	0.05	0.1	0.4
Station Totals												
Individuals	1075		526		42		292		1935		483.8	440.9
Species	9		10		7		11		13		9.3	1.7
Diversity (H')	1.47		1.84		1.78		1.78		1.17		1.7	0.2
Fish measuring less than 30 mm (not included above):												
<i>Genyonemus lineatus</i>	66	106	44	31	7	-	2	3	259			
<i>Seriphus politus</i>	-	-	-	-	-	3	-	-	3			

Appendix H-3. Abundance of fish species in trawl replicates. Reliant Energy Mandalay generating station NPDES, summer 2001.

Species	Station-Replicate								Percent			
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	Total	Total	Mean	S.D.
<i>Seriphus politus</i>	15	81	19	676	181	2534	3	339	3848	87.67	481.0	860.4
<i>Engraulis mordax</i>	13	172	8	25	7	4	2	7	238	5.42	29.8	57.9
<i>Genyonemus lineatus</i>	5	48	-	41	21	9	-	3	127	2.89	15.9	19.0
<i>Syngnathus californiensis</i>	16	30	6	18	3	5	1	-	79	1.80	9.9	10.5
<i>Hyperprosopon argenteum</i>	-	2	1	1	12	11	8	2	37	0.84	4.6	4.9
<i>Synodus lucioceps</i>	2	1	-	3	4	9	-	2	21	0.48	2.6	2.9
<i>Cymatogaster aggregata</i>	1	3	2	3	-	1	-	-	10	0.23	1.3	1.3
<i>Citharichthys stigmaeus</i>	-	-	-	-	2	2	3	1	8	0.18	1.0	1.2
<i>Platyrrhinoidis triseriata</i>	-	-	-	3	-	-	-	-	3	0.07	0.4	1.1
<i>Pleuronichthys ritteri</i>	-	-	-	-	-	2	1	-	3	0.07	0.4	0.7
<i>Amphistichus argenteus</i>	-	2	-	-	-	-	-	-	2	0.05	0.3	0.7
<i>Peprilus simillimus</i>	-	1	-	1	-	-	-	-	2	0.05	0.3	0.5
<i>Pleuronichthys verticalis</i>	-	-	-	-	1	-	1	-	2	0.05	0.3	0.5
<i>Aulorhynchus flavidus</i>	-	1	-	-	-	-	-	-	1	0.02	0.1	0.4
<i>Menticirrhus undulatus</i>	-	-	-	-	-	1	-	-	1	0.02	0.1	0.4
<i>Myliobatis californica</i>	-	-	-	1	-	-	-	-	1	0.02	0.1	0.4
<i>Phanerodon furcatus</i>	-	-	-	-	-	-	-	1	1	0.02	0.1	0.4
<i>Porichthys notatus</i>	-	-	-	-	-	1	-	-	1	0.02	0.1	0.4
<i>Sardinops sagax</i>	-	-	1	-	-	-	-	-	1	0.02	0.1	0.4
<i>Squalus acanthias</i>	-	-	-	-	-	1	-	-	1	0.02	0.1	0.4
<i>Squatina californica</i>	-	-	-	1	-	-	-	-	1	0.02	0.1	0.4
<i>Xystreus liolepis</i>	-	-	-	-	-	-	1	-	1	0.02	0.1	0.4
Station Totals												
Individuals	393		810		2811		375		4389		1097.3	1160.0
Species	10		12		13		11		22		11.5	1.3
Diversity (H')	1.74		0.79		0.47		0.54		0.58		0.71	0.64
Fish measuring less than 30 mm (not included above):												
<i>Genyonemus lineatus</i>	-	2	-	-	-	-	-	-	2			

**Appendix H-4. Biomass (kg) of fish species in trawl replicates. Reliant Energy Mandalay generating station NPDES, winter 2001.**

Species	Station-Replicate								Total	Percent		
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II		Total	Mean	S.D.
<i>Myliobatis californica</i>	9.800	1.650	0.530	0.405	-	-	-	-	12.385	56.33	1.548	3.381
<i>Seriphus politus</i>	1.982	0.140	0.358	0.245	0.020	0.006	0.195	0.052	2.998	13.64	0.375	0.660
<i>Menticirrhus undulatus</i>	0.022	0.332	0.700	0.260	-	-	1.320	0.278	2.912	13.24	0.364	0.452
<i>Genyonemus lineatus</i>	0.587	0.252	0.401	0.337	0.012	-	0.448	0.057	2.094	9.52	0.262	0.220
<i>Paralichthys californicus</i>	-	-	-	-	-	-	-	0.570	0.570	2.59	0.071	0.202
<i>Engraulis mordax</i>	0.225	0.032	0.030	0.065	0.002	0.090	0.003	0.015	0.462	2.10	0.058	0.074
<i>Amphistichus argenteus</i>	-	0.033	-	0.058	0.090	0.035	0.014	0.025	0.255	1.16	0.032	0.030
<i>Citharichthys stigmæus</i>	-	0.034	0.055	0.005	0.006	0.005	0.010	0.041	0.156	0.71	0.020	0.021
<i>Syngnathus californiensis</i>	0.012	0.019	0.005	0.004	0.003	-	0.003	0.006	0.052	0.24	0.007	0.006
<i>Platyrrhinoidis triseriata</i>	0.015	-	0.010	-	-	-	-	0.019	0.044	0.20	0.006	0.008
<i>Synodus lucioceps</i>	-	-	-	-	0.003	0.004	0.003	0.012	0.022	0.10	0.003	0.004
<i>Umbrina roncadore</i>	-	-	0.020	-	-	-	-	-	0.020	0.09	0.003	0.007
<i>Cymatogaster aggregata</i>	-	-	-	-	-	-	0.017	-	0.017	0.08	0.002	0.006
Station Totals												
Biomass	15.135		3.488		0.276		3.088		21.987		5.497	6.583
Fish measuring less than 30 mm (not included above):												
<i>Genyonemus lineatus</i>	0.001	0.013	0.020	0.009	0.002	-	0.001	0.001	0.047			
<i>Seriphus politus</i>	-	-	-	-	-	0.001	-	-	0.001			

**Appendix H-5. Biomass (kg) of fish species in trawl replicates. Reliant Energy Mandalay generating station NPDES, summer 2001.**

Species	Station-Replicate								Total	Percent		
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II		Mean	S.D.	
<i>Seriphus politus</i>	0.099	0.856	0.214	8.320	2.192	28.206	0.021	3.448	43.356	66.98	5.420	9.616
<i>Squatina californica</i>	-	-	-	11.300	-	-	-	-	11.300	17.46	1.413	3.995
<i>Squalus acanthias</i>	-	-	-	-	-	3.050	-	-	3.050	4.71	0.381	1.078
<i>Engraulis mordax</i>	0.104	1.563	0.077	0.227	0.075	0.050	0.020	0.077	2.193	3.39	0.274	0.524
<i>Platyrrhinoidis triseriata</i>	-	-	-	1.204	-	-	-	-	1.204	1.86	0.151	0.426
<i>Genyonemus lineatus</i>	0.025	0.314	-	0.319	0.230	0.196	-	0.042	1.126	1.74	0.141	0.139
<i>Myliobatis californica</i>	-	-	-	0.877	-	-	-	-	0.877	1.35	0.110	0.310
<i>Synodus lucioceps</i>	0.043	0.009	-	0.046	0.093	0.209	-	0.034	0.434	0.67	0.054	0.070
<i>Hyperprosopon argenteum</i>	-	0.014	0.006	0.012	0.077	0.067	0.055	0.017	0.248	0.38	0.031	0.030
<i>Menticirrhus undulatus</i>	0	0	-	-	-	0.232	-	-	0.232	0.36	0.029	0.082
<i>Syngnathus californiensis</i>	0.024	0.065	0.013	0.034	0.008	0.016	0.002	-	0.162	0.25	0.020	0.021
<i>Xystreurus liolepis</i>	-	-	-	-	-	-	0.157	-	0.157	0.24	0.020	0.056
<i>Cymatogaster aggregata</i>	0.027	0.025	0.022	0.021	-	0.026	-	-	0.121	0.19	0.015	0.013
<i>Pleuronichthys verticalis</i>	-	-	-	-	0.024	-	0.066	-	0.090	0.14	0.011	0.024
<i>Sardinops sagax</i>	-	-	0.053	-	-	-	-	-	0.053	0.08	0.007	0.019
<i>Amphistichus argenteus</i>	-	0.034	-	-	-	-	-	-	0.034	0.05	0.004	0.012
<i>Peprilus simillimus</i>	-	0.018	-	0.016	-	-	-	-	0.034	0.05	0.004	0.008
<i>Porichthys notatus</i>	-	-	-	-	-	0.022	-	-	0.022	0.03	0.003	0.008
<i>Citharichthys stigmæus</i>	-	-	-	-	0.005	0.003	0.012	0.001	0.021	0.03	0.003	0.004
<i>Pleuronichthys ritteri</i>	-	-	-	-	-	0.006	0.003	-	0.009	0.01	0.001	0.002
<i>Phanerodon furcatus</i>	-	-	-	-	-	-	-	0.005	0.005	0.01	0.001	0.002
<i>Aulorhynchus flavidus</i>	-	0.003	-	-	-	-	-	-	0.003	0.00	0.000	0.001
Station Totals												
Biomass	3.223		22.761		34.787		3.960		64.731		16.183	15.349
Fish measuring less than 30 mm (not included above):												
<i>Genvonemus lineatus</i>	-	0.001	-	-	-	-	-	-	0.001			

Note: 0.00 = <0.01

Species	Sta-Rep	Length (mm)																			
<i>Amphistichus argenteus</i>	T1-II	110																			
	T2-II	92																			
	T3-I	115	124																		
	T3-II	105																			
	T4-I	105																			
	T4-II	113																			
<i>Citharichthys stigmæus</i>	T1-II	81	112																		
	T2-I	80	75	86	69	80	82	76	62	75	25										
	T2-II	26	80																		
	T3-I	75																			
	T3-II	65	76																		
	T4-I	80	78	73	22	25															
	T4-II	82	80	70	79	78	75	84	72	78											
<i>Cymatogaster aggregata</i>	T4-I	116																			
<i>Engraulis mordax</i>	T1-I	75	75	68	102	85	68	70	71	70	76	73	64	77	70	95	62	70	81	70	65
		73	36	71	69	68	70	65	74	66	70	85	73	69	65	72	80	73	72	64	81
		65	75	72	68	56	52	71	65	66	70	64	63	61	65	85	66	70	52	78	70
		67	67	71	70	70	78														
	T1-II	87	74	62	70	70	81														
	T2-I	96	79	62	76	105	70	66	58	85	80	72	65	55	52	70	98				
	T2-II	78	87	87	77	61	88	56	85	74	74	78	72	73	47	67	70	72	53	88	77
	T3-I	50	50																		
	T3-II	85	87	89	75	76	105	82	74	67	76	75	74	73	78	76	75	85	78	89	75
		82																			
	T4-I	42	66	46	45	65															
	T4-II	47	48	76	56	46	70	66	44	64											
<i>Genyonemus lineatus</i>	T1-I	48	62	60	44	51	37	51	55	57	48	42	45	47	45	46	35	50	40	30	45
		42	31	50	40	56	55	38	35	42	56	35	31	57	48	53	49	42	34	40	42
		48	45	55	43	52	53	41	45	53	56	50	45	46	57	45	54	42	41	57	43
		38	41	35	45	48	48	52	55	44	36	35	51	56	49	34	44	45	41	34	33
		41	45	33	36	35	50	37	51	56	45	52	41	57	32	50	35	57	49	45	

## Appendix H-6. (Cont.).

Species	Sta-Rep	Length (mm)																			
<i>Genyonemus lineatus</i> cont.		46	42	53	53	52	55	53	53	53	49	55	52	45	60	42	44	40	52	53	55
		55	57	58	60	52	50	54	45	90	46	45	35	62	47	55	59	55	59	53	52
		55	58	47	43	56	62	55	56	78	50	49	59	46	57	52	46	45	46	56	52
		48	65	54	55	47	42	51	55	40	39	52	45	52	48	53	52	56	56	62	56
		42	56	60	52	57	46	45	50												
	T4-I	36	44	56	53	47	111	54	42	43	54	46	50	50	56	55	70	63	53	50	55
		76	50	35	45																
<i>Menticirrhus undulatus</i>	T1-I	134																			
	T1-II	241	210																		
	T2-I	160	220	202	148	146	149	156	250												
	T2-II	158	213																		
	T4-I	229	227	201	216	213	232	204	212												
	T4-II	246	190																		
<i>Myliobatis californica</i>	T1-I	TL	1045																		
		DW	777																		
	T1-II	TL	875																		
		DW	457																		
	T2-I	TL	544																		
		DW	352																		
<i>Paralichthys californicus</i>	T2-II	TL	455																		
		DW	297																		
<i>Paralichthys californicus</i>	T4-II	329																			
<i>Platyrrhinoidis triseriata</i>	T1-I	TL	150																		
		DW	65																		
	T2-I	162																			
	T4-II	142																			
<i>Seriphus politus</i>	T1-I	138	55	57	63	74	53	78	78	75	62	71	71	55	65	60	73	72	67	52	71
		71	62	72	73	69	75	70	73	60	64	69	72	80	63	51	61	84	45	78	60
		61	82	69	57	62	57	70	71	70	72	66	65	67	60	55	56	59	80	58	56
		65	63	71	68	50	65	65	61	57	52	54	63	72	74	81	60	85	80	56	50
		63	71	60	54	70	75	70	83	64	71	65	68	50	70	62	54	50	78	78	66
		76	44	70	68	52	65	65	66	72	70	75	53	54	60	72	71	74	84	63	71
		81	64	62	51	51	63	53	72	71	70	62	51	72	55	61	66	65	62	73	70
		72	58	76	58	55	54	70	71	73	62	55	56	63	58	71	50	63	50	60	62
		58	72	73	70	75	71	82	68	65	55	67	75	47	75	51	50	73	52	69	51
		60	62	68	60	63	79	53	67	50	68	60	77	52	53	70	54	62	55	65	49
	T1-II	65	55	51	50	51	63	52	53	45	56	63	58	57	70	72	51	55	61	62	65
		63	65	56	60	71	56	55	52	77	56	64	51	54	69	61	65	53	52	54	70
		55	62	63	56	61															
	T2-I	53	58	52	83	49	55	66	62	55	65	65	55	46	82	60	92	50	66	70	55
		55	70	45	62	60	62	62	60	50	70	65	76	57	42	76	70	56	54	65	58
		65	63	82	76	54	57	58	49	55	55	76	53	88	75	50	52	65	75	52	44
		75	66	50	50	43	76	72	82	62	46	42	54	53	53	54	42	79	50	57	83
		72	60	75	70	48	45	44	54	55	46	53	55	46	56	45	56	52	40	65	49
		53	57	61																	
	T2-II	74	51	72	73	49	53	54	63	49	72	81	69	54	49	61	61	46	56	55	47
		59	53	50	64	66	52	52	67	60	63	60	61	56	80	61	53	56	54	50	62
		57	62	70	72	64	57	52	78	81	57	72	50	63	46	53	68	58	53	70	49
		51	60	55	69	54	63	53	58	52	56	55	71	48	56	70	54	55	52	73	42
		68	52	55	61	55	54	70	52	53	52	53	63	66	60	79	58	55	63	54	53
		73	68	52	66	56	50	53	53	50											
	T3-I	71	56	59	55	52	55														
	T3-II	53	66																		
	T4-I	76	51	80	73	55	65	70	56	70	70	57	72	59	58	65	56	55	51	58	70
		76	52	67	57	59	79	70	68	80	68	85	56	82	70	70	65	75	56	69	68
		55	70	76	72	50															
	T4-II	56	56	54	49	75	66	76	54	67	62	70	75	57	70	64	68	65	75	54	48
		52	53																		

Appendix H-6. (Cont.).

Species	Sta-Rep	Length (mm)							
<i>Syngnathus californiensis</i>									
	T1-I	211	167	204	201	205	148	226	
	T1-II	177	262	183	165	157	196	228	
	T2-I	253	167						
	T2-II	180	130						
	T3-I	272							
	T4-I	200	146	177	209				
	T4-II	236	212	208					
<i>Synodus lucioceps</i>									
	T3-I	89							
	T3-II	86							
	T4-I	93							
	T4-II	88	98						
<i>Umbrina roncadore</i>									
	T2-I	68	76	81					

TL = Total Length, DW = Disc Width

Fish measuring less than 30 mm (not included above):

Species	Station-Replicate								Total
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	
<i>Genyonemus lineatus</i>	66	106	44	31	7	-	2	3	259
<i>Seriphus politus</i>	-	-	-	-	-	3	-	-	3

Fish diseases, abnormalities, and parasitism:

Species	Sta-Rep	Length (mm)	Note
<i>Engraulis mordax</i>	T1-I	73	<i>Elthusa californica</i>
<i>Genyonemus lineatus</i>	T1-II	60	<i>Elthusa californica</i>
<i>Seriphus politus</i>	T1-I	71	<i>Elthusa californica</i>
<i>Seriphus politus</i>	T1-II	45	<i>Nerocila</i> sp
<i>Seriphus politus</i>	T4-I	55	<i>Elthusa californica</i>

Appendix H-7. Length of fish species in trawl replicates. Reliant Energy Mandalay generating station NPDES, summer 2001.

Species	Sta-Rep	Length (mm)																			
<i>Amphistichus argenteus</i>																					
T1-II	88	83																			
<i>Aulorhynchus flavidus</i>																					
T1-II	98																				
<i>Citharichthys stigmaeus</i>																					
T3-I	55	48																			
T3-II	54	46																			
T4-I	25	77	45																		
T4-II	28																				
<i>Cymatogaster aggregata</i>																					
T1-I	100																				
T1-II	103	45	36																		
T2-I	97	45																			
T2-II	105	97	40																		
T3-II	87																				
<i>Engraulis mordax</i>																					
T1-I	111	107	91	103	106	102	108	103	95	87	93	97	85								
T1-II	98	97	92	90	103	96	95	104	93	94	94	86	88	89	103	97	95	95	104	96	
	82	83	95	89	104	92	112	101	104	94	103	99	91	93	89	75	95	94	103	97	
	98	92	85	105	103	92	93	94	93	88	88	106	99	79	99	91	103	89	88	112	
	106	102	114	92	97	86	93	101	109	93	99	96	95	91	100	58	83	86	92	99	
	93	96	91	97	88	105	93	96	95	91	83	92	121	94	96	99	102	85	89	95	
	89	100	106	85	103	89	106	65	93	100	96	92	95	104	98	106	101	96	91	90	
	93	96	97	90	88	82	88	83	105	90	96	87	101	87	99	90	104	92	110	103	
	93	107	80	88	93	92	93	61	97	98	93	69	93	85	95	97	102	102	95	103	
	96	92	92	103	101	75	99	87	60	90	100	88									
T2-I	105	108	117	106	104	103	100	103													
T2-II	109	103	113	108	112	109	108	105	109	110	102	112	114	115	105	80	69	107	103	104	
	113	111	110	107	99																
T3-I	105	114	128	116	113	115	45														
T3-II	112	110	115	112																	
T4-I	111	114																			
T4-II	110	115	110	110	93	115	107														
<i>Genyonemus lineatus</i>																					
T1-I	59	50	56	54	64																
T1-II	60	93	70	65	90	70	67	72	75	65	59	74	65	55	57	79	76	65	52	68	
	54	70	66	58	50	61	59	73	46	66	55	52	78	90	50	62	60	133	70	75	
	70	68	72	60	65	68	32	65													
T2-II	115	82	97	71	65	70	68	81	62	70	63	60	68	70	75	85	75	76	46	63	
	71	64	65	70	69	65	88	66	71	73	72	67	65	80	69	68	83	90	69	94	
	83																				
T3-I	85	86	80	82	88	70	82	71	70	87	142	75	79	80	69	128	70	75	70	90	
	79																				
T3-II	112	145	134	109	81	83	81	132	87												
T4-II	95	84	84																		
<i>Hyperprosopon argenteum</i>																					
T1-II	66	61																			
T2-I	63																				
T2-II	71																				
T3-I	74	69	65	67	72	70	62	70	68	65	64	73									
T3-II	75	75	64	58	61	66	64	53	63	72	60										
T4-I	68	68	67	70	75	68	69	62													
T4-II	70	71																			
<i>Menticirrhus undulatus</i>																					
T3-II	264																				
<i>Myliobatis californica</i>																					
T2-II	DW	392																			
	TL	571																			

Appendix H-7 (Cont.).

Species	Sta-Rep	Length (mm)																			
<i>Peprilus simillimus</i>																					
T1-II	106																				
T2-II	77																				
<i>Phanerodon furcatus</i>																					
T4-II	55																				
<i>Platyrrhinoidis triseriata</i>																					
T2-II	400	390	381																		
<i>Pleuronichthys ritteri</i>																					
T3-II	62	55																			
T4-I	52																				
<i>Pleuronichthys verticalis</i>																					
T3-I	114																				
T4-I	140																				
<i>Porichthys notatus</i>																					
T3-II	148																				
<i>Sardinops sagax</i>																					
T2-I	166																				
<i>Seriphus politus</i>																					
T1-I	70	81	78	75	83	76	74	91	83	72	81	75	70	71	77						
T1-II	87	92	103	92	92	89	103	87	95	86	93	93	91	89	88	76	85	77	90	90	
	87	88	70	88	93	92	75	82	83	87	88	90	88	83	102	89	94	77	85	85	
	88	80	67	93	85	84	90	87	75	102	80	100	87	80	87	83	91	89	93	88	
	92	82	95	93	97	92	86	92	85	92	92	91	74	71	65	93	95	99	86	92	
	80																				
T2-I	85	78	93	86	91	68	130	85	132	88	84	95	86	85	88	89	103	87	109		
T2-II	95	97	87	66	95	104	94	95	86	85	89	86	79	88	100	89	94	79	102	99	
	87	78	95	94	89	97	83	98	103	87	93	101	112	87	90	91	98	88	97	99	
	92	93	98	77	95	102	89	87	88	81	90	89	88	82	85	147	110	79	80	94	
	74	97	79	160	92	81	93	90	95	87	93	102	73	91	85	75	92	72	97	88	
	80	79	89	82	68	94	89	96	85	77	93	94	110	102	75	74	85	85	88	52	
	120	87	91	76	91	77	88	88	90	100	97	94	91	75	86	92	94	80	110	90	
	97	74	90	90	88	76	102	84	89	95	84	74	100	95	91	89	96	97	80	66	
	93	92	82	85	106	92	83	95	93	93	87	95	91	89	91	95	92	87	85	88	
	95	67	90	90	89	91	83	90	88	82	90	81	89	95	92	84	99	90	117	90	
	87	84	73	88	83	115	85	100	96	94	102	82	89	90	71	85	89	90	102	84	
T3-I	101	84	87	77	102	88	95	123	92	91	94	84	101	84	86	98	87	127	111	123	
	91	94	108	103	90	101	89	106	92	95	93	113	89	86	76	93	104	89	87	89	
	87	84	109	89	93	87	99	88	72	92	99	131	100	88	87	71	91	92	86	88	
	104	95	87	92	79	86	90	108	87	95	96	98	103	90	105	91	88	125	101	85	
	90	85	110	74	95	95	89	90	103	80	87	90	97	83	98	90	87	110	112	84	
	107	87	83	96	95	89	106	87	102	83	87	84	107	86	105	100	88	95	100	88	
	89	93	106	90	87	92	111	92	87	101	100	105	88	82	89	81	107	85	88	87	
	74	94	86	89	107	74	85	94	94	87	86	73	90	92	110	91	91	87	87	139	
	99	94	75	90	96	80	91	96	91	82	87	92	88	82	92	80	85	92	86	91	
	96																				
T3-II	82	103	95	87	97	83	94	102	90	90	86	92	91	90	87	85	83	90	86	92	
	92	113	88	85	93	90	90	85	95	89	80	127	90	89	83	91	99	90	88	86	
	85	98	85	74	99	100	95	90	82	80	103	117	86	85	94	95	94	76	109	88	
	103	81	95	88	80	84	84	85	88	95	92	89	97	95	88	89	84	90	90	93	
	88	90	95	92	104	91	88	88	100	94	79	85	96	103	87	84	83	90	85	84	
	74	90	75	96	88	90	87	86	93	92	88	89	72	84	93	92	95	107	88	87	
	92	80	108	92	95	85	85	85	92	96	99	82	93	91	88	90	93	88	90	78	
	97	85	79	85	87	83	90	94	85	80	82	90	83	88	92	102	91	83	90	81	
	85	67	81	86	89	125	90	85	81	95	103	101	65	104	100	104	100	96	97	85	
	92	92	91	107	84	90	87	95	86	83	92	81	85	95	91	88	85	80	95	88	
T4-I	86	75	83																		
T4-II	91	95	93	95	90	97	88	80	147	85	88	83	83	89	89	74	89	85	93	87	
	116	96	94	90	99	97	85	90	94	82	90	80	93	87	86	85	84	93	78	82	
	83	87	85	85	84	92	88	88	102	100	90	74	82	86	75	91	84	87	85	93	
	88	89	83	87	90	99	100	74	88	87	83	85	72	105	92	87	90	84	104	90	
	81	86	87	94	81	85	86	80	78	83	88	82	85	80	90	86	87	112	90	99	
	96	70	108	85	80	90	92	101	93	78	95	78	90	82	89	85	84	106	82	79	

Appendix H-7 (Cont.).

Species	Length (mm)																			
Sta-Rep																				
<i>Seriphus politus</i> (Cont.)																				
113	90	102	90	87	82	78	92	80	90	85	90	91	87	92	80	69	85	86	75	
94	86	82	86	85	100	76	95	78	85	73	78	89	101	90	87	86	87	93	92	
79	88	75	84	82	81	110	85	88	84	96	78	86	90	85	80	95	79	74	93	
83	87	94	83	98	81	78	93	85	84	113	96	90	79	85	97	84	83	86	86	
<i>Squalus acanthias</i>																				
T3-II	880																			
<i>Squatina californica</i>																				
T2-II	1005																			
<i>Sygnathus californiensis</i>																				
T1-I	213	217	207	190	221	224	193	206	196	192	221	220	177	197	180	207				
T1-II	186	220	218	205	192	202	178	181	218	185	169	200	245	201	226	216	178	220	216	188
	178	202	218	206	228	197	216	180	177	196										
T2-I	219	227	233	212	246	190														
T2-II	213	223	224	203	204	194	206	207	194	204	200	185	187	192	218	196	159	217		
T3-I	206	229	166																	
T3-II	215	214	229	213	213															
T4-I	210																			
<i>Synodus lucioceps</i>																				
T1-I	129	123																		
T1-II	132																			
T2-II	136	155	125																	
T3-I	141	150	125	171																
T3-II	149	175	143	161	135	154	147	154	148											
T4-II	155	136																		
<i>Xystreureys liolepis</i>																				
T4-I	190																			

TL = Total Length, DW = Disk Width

Fish measuring less than 30 mm (not included above):

	Station -Replicate								Total
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	
<i>Genyonemus lineatus</i>	-	2	-	-	-	-	-	-	2

Fish diseases, abnormalities, and parasitism:

Species	Sta-Rep	Length	Note
<i>Seriphus politus</i>	T1-II	82	<i>Elthusa</i> sp
<i>Seriphus politus</i>	T3-II	90	<i>Elthusa</i> sp
<i>Seriphus politus</i>	T4-II	88	<i>Elthusa</i> sp
<i>Seriphus politus</i>	T4-II	86	<i>Elthusa</i> sp
<i>Seriphus politus</i>	T4-II	84	<i>Elthusa</i> sp

Appendix H-8. Abundance of macroinvertebrate species in trawl replicates. Reliant Energy Mandalay generating station NPDES, winter 2001.

Species	Station-Replicate								Percent			
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	Total	Total	Mean	S.D.
<i>Dendroaster exentricus</i>	349	607	278	628	457	519	439	605	3882	87.28	485.3	128.2
<i>Crangon nigromaculata</i>	88	86	160	116	6	-	16	10	482	10.84	60.3	60.4
<i>Cancer gracilis</i>	7	16	1	2	7	11	11	23	78	1.75	9.8	7.3
<i>Panulirus interruptus</i>	-	-	1	-	-	-	1	1	3	0.07	0.4	0.5
<i>Caudina arenicola</i>	-	-	1	-	-	-	-	-	1	0.02	0.1	0.4
<i>Portunus xantusii</i>	-	-	-	1	-	-	-	-	1	0.02	0.1	0.4
<i>Pyromaia tuberculata</i>	-	1	-	-	-	-	-	-	1	0.02	0.1	0.4
Station totals												
Number of individuals	1154		1188		1000		1106		4448		1112.0	81.9
Number of species	4		6		3		4		7		4.3	1.3
Diversity (H')	1.19		1.21		0.81		0.94		0.44		1.04	0.19

Appendix H-9. Abundance of macroinvertebrate species in trawl replicates. Reliant Energy Mandalay generating station NPDES, summer 2001.

Species	Station-Replicate								Percent			
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	Total	Total	Mean	S.D.
<i>Dendroaster exentricus</i>	78	218	45	483	1602	1336	1065	3052	7879	96.51	984.9	1023.3
<i>Crangon nigromaculata</i>	7	29	20	103	22	45	16	8	250	3.06	31.3	31.4
<i>Cancer gracilis</i>	1	6	1	1	1	1	5	9	25	0.31	3.1	3.1
<i>Heptacarpus palpator</i>	-	-	-	1	-	2	-	-	3	0.04	0.4	0.7
<i>Callinotoma sp</i>	-	-	-	-	-	-	1	1	2	0.02	0.3	0.5
<i>Pyromaia tuberculata</i>	-	1	-	1	-	-	-	-	2	0.02	0.3	0.5
<i>Cancer anthonyi</i>	-	-	-	1	-	-	-	-	1	0.01	0.1	0.4
<i>Nassarius perpinguis</i>	-	-	-	-	1	-	-	-	1	0.01	0.1	0.4
<i>Renilla kollikeri</i>	-	-	-	-	-	-	-	1	1	0.01	0.1	0.4
Station totals												
Number of individuals	340		656		3010		4158		8164		2041.0	1841.5
Number of species	4		6		6		5		9		5.3	1.0
Diversity (H')	1.02		0.86		0.81		0.64		0.169		0.83	0.16

Appendix H-10. Biomass (kg) of macroinvertebrate species in trawl replicates. Reliant Energy Mandalay generating station NPDES, winter 2001.

Species	Station-Replicate								Percent			
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	Total	Total	Mean	S.D.
<i>Dendroaster exentricus</i>	1.497	2.167	1.100	2.480	1.850	2.100	1.800	2.450	15.444	85.577	1.931	0.472
<i>Crangon nigromaculata</i>	0.325	0.325	0.245	0.177	0.008	-	0.007	0.020	1.107	6.134	0.138	0.146
<i>Panulirus interruptus</i>	-	-	0.300	-	-	-	0.570	0.230	1.100	6.095	0.138	0.213
<i>Cancer gracilis</i>	0.015	0.089	0.003	0.007	0.040	0.060	0.044	0.115	0.373	2.067	0.047	0.040
<i>Caudina arenicola</i>	-	-	0.020	-	-	-	-	-	0.020	0.111	0.003	0.007
<i>Portunus xantusii</i>	-	-	-	0.002	-	-	-	-	0.002	0.011	0.000	0.001
<i>Pyromaia tuberculata</i>	-	0.001	-	-	-	-	-	-	0.001	0.006	0.000	0.000
Station totals												
Biomass	4.419		4.334		4.058		5.236		18.047		4.51	0.51

Note: 0.000 = <0.0005

Appendix H-11. Biomass (kg) of macroinvertebrate species in trawl replicates. Reliant Energy Mandalay generating station NPDES, summer 2001.

Species	Station-Replicate								Percent			
	T1-I	T1-II	T2-I	T2-II	T3-I	T3-II	T4-I	T4-II	Total	Total	Mean	S.D.
<i>Dendroaster exentricus</i>	0.312	1.045	0.165	2.900	9.141	8.05	5.910	16.850	44.373	98.596	5.547	5.741
<i>Crangon nigromaculata</i>	0.028	0.052	0.044	0.215	0.045	0.065	0.031	0.009	0.489	1.087	0.061	0.064
<i>Cancer gracilis</i>	0.008	0.018	0.001	0.007	0.001	0.001	0.033	0.055	0.124	0.276	0.016	0.019
<i>Renilla kollikeri</i>	-	-	-	-	-	-	-	0.008	0.008	0.018	0.001	0.003
<i>Pyromaia tuberculata</i>	-	0.003	-	0.002	-	-	-	-	0.005	0.011	0.001	0.001
<i>Caliostoma</i> sp	-	-	-	-	-	-	0.001	0.001	0.002	0.004	0.000	0.000
<i>Heptacarpus palpator</i>	-	-	-	0.001	-	0.001	-	-	0.002	0.004	0.000	0.000
<i>Cancer anthonyi</i>	-	-	-	0.001	-	-	-	-	0.001	0.002	0.000	0.000
<i>Nassarius perpinguis</i>	-	-	-	-	0.001	-	-	-	0.001	0.002	0.000	0.000
Station totals												
Biomass	1.466		3.336		17.305		22.898		45.005		11.25	10.50

Note: 0.000 = <0.0005

Appendix H-12. Abundance of fish species in trawl replicates, 1978 - 2001. Reliant Energy Mandalay generating station NPDES, 2001.

Species	1978		1980		1986		1988		1990		1991		1992		1993		1994		1997		1999		2000		2001		Total	Percent Total
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S		
<i>Genyonemus lineatus</i>	2129	4584	4174	4272	302	1162	1150	598	994	382	1809	1692	1064	30	3013	300	8937	20	76	287	906	4369	994	4369	906	127	41471	49.532
<i>Seriophilus polius</i>	371	595	4183	706	400	430	18	177	794	163	788	553	4406	265	2744	1185	4298	762	3848	29777	762	3848	762	3848	762	3848	29777	35.565
<i>Engraulis mordax</i>	218	1258	221	273	2	2	52	23	65	359	359	1211	258	159	88	27	27	17	35	605	145	238	145	238	145	238	5493	6.561
<i>Amphichthys argenteus</i>	95	115	96	76	10	36	173	35	38	7	88	2	27	99	16	25	16	18	1	1	103	40	96	123	30	8	943	1.126
<i>Citharichthys stigmatus</i>	29	7	4	4	18	22	35	29	35	41	180	37	3	3	1	52	23	13	3	7	103	40	96	123	30	8	943	1.126
<i>Hyperprosopon argenteum</i>	107	228	198	142	1	7	1	17	1	1	50	2	3	1	25	7	21	1	1	1	1	1	16	1	37	865	1.033	
<i>Phanerodon furcatus</i>	32	213	78	243	1	2	17	1	18	1	26	1	4	1	5	1	80	12	12	1	25	1	1	1	1	1	757	0.904
<i>Cymatogaster aggregata</i>	59	48	1	23	1	23	4	4	33	1	62	1	3	2	56	1	87	17	10	190	42	42	1	10	1	10	641	0.766
<i>Platyrrhinoides triseriata</i>	2	25	15	6	4	8	13	3	6	44	12	4	4	30	137	2	2	3	3	4	9	5	9	3	3	347	0.414	
<i>Syngnathus californiensis</i>	3	22	3	51	4	62	5	53	1	20	12	15	1	1	3	5	1	10	2	2	2	5	5	1	1	279	0.333	
<i>Paralichthys californicus</i>	15	2	1	1	73	6	1	1	1	3	3	1	1	1	31	2	19	1	2	2	2	64	9	23	1	253	0.302	
<i>Merluccius undulatus</i>	2	2	1	1	11	1	1	1	1	1	1	1	1	1	79	1	50	1	1	1	1	1	1	3	1	147	0.176	
<i>Umbra lineolata</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	14	44	1	39	1	1	1	1	1	1	143	0.171
<i>Syngnathus exilis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Xyateurus loilepis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Ophiodon elongatus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Pleuronectes vetulus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Rhinogobius productus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Syngnathus spp</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Pegophilus similis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Pleuronichthys verticalis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Synodus lucioceps</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Squalus acanthias</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Hypsopsetta guttulata</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Leptocottus armatus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Pleuronichthys ritteri</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Myliobatis californica</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Hyperprosopon anale</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Sardinops sagax</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Brachyistius frenatus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Atherinops californiensis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Atractoscion nobilis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Rhacochilus vacca</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Atherinops affinis</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Mustelus californicus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Embioca jacksoni</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Sphyrna argentea</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Squalina californica</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Triakis semifasciata</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Mustelus henlei</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Sebastes auriculatus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Raja inornata</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Zalambius rosaceus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Porichthys myriaster</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Symphurus carinatus</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139
<i>Anchoa mitchilli</i>	1	2	1	10	1	17	1	10	1	1	3	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	116	0.139

## **APPENDIX I**

**Fish and macroinvertebrate heat treatment and normal operation data**

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Appendix I-1. Master species list of fish and macroinvertebrate species impinged during heat treatments and normal operations. Reliant Energy Mandalay generating station NPDES, 2001.

PHYLUM	Class	Family	Species	Common Name
MOLLUSCA				
	Gastropoda			
		Aplysiidae		
			<i>Aplysia</i> sp	sea hare, unidentified
	Cephalopoda			
		Loliginidae		
			<i>Loligo opalescens</i>	California market squid
		Octopodidae		
			<i>Octopus bimaculoides</i>	California two-spot octopus
ARTHROPODA				
	Malacostraca			
		Cancridae		
			<i>Cancer antennarius</i>	Pacific rock crab
		Grapsidae		
			<i>Pachygrapsus crassipes</i>	striped shore crab
VERTEBRATA				
	Elasmobranchiomorphi (= Chondrichthyes, Elasmobranchii)			
		Urolophidae (Dasyatidae, in part)		
			<i>Urolophus halleri</i>	round stingray
	Osteichthyes (=Actinopterygii)			
		Engraulidae		
			<i>Engraulis mordax</i>	northern anchovy
		Syngnathidae		
			<i>Sygnathus</i> sp	pipefish, unidentified
		Cottidae		
			<i>Leptocottus armatus</i>	Pacific staghorn sculpin
		Embiotocidae		
			<i>Cymatogaster aggregata</i>	shiner perch
		Bothidae		
			<i>Paralichthys californicus</i>	California halibut

**Appendix I-2. Abundance of fish impinged during heat treatments and normal operations between 1 October 2000 and 30 September 2001. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Heat Treatment	Monitored Normal Operations	Extrapolated Normal Operations*	Total	Percent
	Abund.	Abund.	Abund.	Abundance	Total
<i>Lepotocottus armatus</i>	-	3	81	81	43.5
<i>Cymatogaster aggregata</i>	3	1	24	27	14.5
<i>Paralichthys californicus</i>	-	1	27	27	14.5
<i>Syngathus sp</i>	-	1	24	24	12.9
<i>Urolophus halleri</i>	-	1	24	24	12.9
<i>Engraulis mordax</i>	3	-	-	3	1.6
Number of individuals	6	7	180	186	
Number of species	2	5	5	6	

\* Extrapolations based on flow during month sampled divided by flow on date sampled, multiplied by abundance on sampling date. Two days sampled during year, totaling 0.61% of the annual circulation through plant.

**Appendix I-3. Biomass (kg) of fish impinged during heat treatments and normal operations between 1 October 2000 and 30 September 2001. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Heat Treatment	Monitored Normal Operations	Extrapolated Normal Operations*	Total	Percent
	Biomass	Biomass	Biomass	Biomass	Total
<i>Urolophus halleri</i>	-	0.251	6.114	6.114	63.8
<i>Lepotocottus armatus</i>	-	0.090	2.417	2.417	25.2
<i>Cymatogaster aggregata</i>	0.100	0.021	0.512	0.612	6.4
<i>Paralichthys californicus</i>	-	0.010	0.269	0.269	2.8
<i>Engraulis mordax</i>	0.120	-	-	0.120	1.3
<i>Syngathus sp</i>	-	0.002	0.049	0.049	0.5
Survey totals	0.220	0.374	9.361	9.581	

\* Extrapolations based on flow during month sampled divided by flow on date sampled, multiplied by biomass on sampling date. Two days sampled during year, totaling 0.61% of the annual circulation through plant.

**Appendix I-4. Abundance and biomass (kg) of fish impinged during normal operation by month. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Abundance					Biomass				
	2001		Total	Percent	Cum.	2001		Total	Percent	Cum.
	12-Jun	27-Sep				12-Jun	27-Sep			
<i>Cymatogaster aggregata</i>	1	-	1	14.3	14.3	0.021	-	0.021	5.6	14.3
<i>Leptocottus armatus</i>	-	3	3	42.9	57.1	-	0.090	0.090	24.1	38.3
<i>Paralichthys californicus</i>	-	1	1	14.3	71.4	-	0.010	0.010	2.7	41.0
<i>Syngathus sp</i>	1	-	1	14.3	85.7	0.002	-	0.002	0.5	41.6
<i>Urolophus halleri</i>	1	-	1	14.3	100.0	0.251	-	0.251	67.1	108.7
Number of individuals	3	4	7							
Number of species	3	2	5							
Biomass (kg)						0.274	0.100	0.374		

**Appendix I-5. Abundance and biomass (kg) of macroinvertebrates impinged during normal operation by month. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Abundance					Biomass				
	2001		Total	Percent	Cum.	2001		Total	Percent	Cum.
	12-Jun	27-Sep				12-Jun	27-Sep			
<i>Loligo opalescens</i>	4	1	5	71.4	14.3	0.113	0.024	0.137	36.6	71.4
<i>Pachygrapsus crassipes</i>	-	1	1	14.3	28.6	-	0.030	0.030	8.0	79.4
Number of individuals	4	2	6							
Number of species	1	2	2							
Biomass (kg)						0.113	0.054	0.167		

**Appendix I-6. Abundance and biomass (kg) of macroinvertebrates impinged during heat treatments and normal operations. Reliant Energy Mandalay generating station NPDES, 2001.**

Species	Heat Treatment		Monitored Normal Operations		Extrapolated Normal Operations*		Total	Total
	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass
<i>Loligo opalescens</i>	-	-	5	0.137	124	3.397	124	3.397
<i>Pachygrapsus crassipes</i>	-	-	1	0.030	27	0.806	27	0.806
<i>Aplysia</i> sp	1	0.400	-	-	-	-	1	0.400
<i>Cancer antennarius</i>	1	0.100	-	-	-	-	1	0.100
<i>Octopus bimaculoides</i>	1	0.200	-	-	-	-	1	0.200
Survey totals	3	0.700	6	0.167	151	4.203	154	4.903
Number of species	3		2		2		5	

\* Extrapolations based on flow during month sampled divided by flow on date sampled, multiplied by abundance/biomass on sampling date. Two days sampled during year, totaling 0.61% of the annual circulation through plant.